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# USSR Report

MATERIALS SCIENCE AND METALLURGY



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18 April 1986

USSR REPORT  
MATERIALS SCIENCE AND METALLURGY

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CONSTITUTION OF BORON NITRIDE SURFACE

Kiev SVERKHTVERDYIE MATERIALY in Russian No 5, Sep-Oct 85  
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[Article by V. G. Aleshin, A. N. Sokolov and A. A. Shul'zhenko, Institute of Superhard Materials, UkSSR Academy of Sciences, Kiev]

[Abstract] The surface of thin BN films was studied by the method of x-ray photoelectron spectroscopy with an Mg K<sub>α</sub> radiation source for determination of chemical composition and atomic state. Two kinds of specimens were examined: single crystals of the 125/100 grain fraction produced by multi-component reaction at high temperature under high static pressure and polycrystals produced from α-BN powder by direct α-BN → β-BN transition at approximately 2500 K temperature under approximately 7.7 GPa static pressure. The results revealed a high purity of cubic α-BN surface (30.1 atom.% B+ 63.2 atom.% N+ 2.4 atom.% O+ 4.3 atom.% C) and a high impurity of graphitic β-BN surface (19.9 atom.% B+ 27.7 atom.% N+ 12.1 atom.% O+ 40.3 atom.% C in single crystals produced by reaction and 5.6 atom.% B+ 7.5 atom.% N+ 18.8 atom.% O+ 68.2 atom.% C in polycrystals produced by transition). Specimens of β-BN were also heat treated in air at 473 K and at 1073 K for 1 h at each temperature. In air the oxygen content increased to 16.3 atom.% and then to 26.3 atom.% respectively, the carbon content increased in air as well as under vacuum as a result of diffusion from the bulk of a specimen to its surface. In both cases there occurred a shift from nitrogen excess over boron at 473 K to a boron excess over nitrogen at 1073 K. These results correlate with corresponding x-ray photoelectron spectra of valence electrons and 1s-shell electrons. References 5: 4 Russian, 1 Western.

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## DIFFUSION AT INTERFACE BETWEEN METAL AND DIAMOND LAYER OF GUIDE ROLLER

Kiev SVERKHTVERDYIE MATERIALY in Russian No 5, Sep-Oct 85  
(manuscript received 17 Aug 84) pp 20-23

[Article by V. G. Delevi, I. L. Sukennik, N. P. Dubovik, V. I. Rusakov,  
L. V. Trunevich and Ye. S. Cherepenina, Institute of Superhard Materials,  
UkSSR Academy of Sciences, Kiev]

[Abstract] An experimental study of nickel-diamond composite coatings galvanically deposited on the tool surface was made, for the purpose of evaluating the bond strength attainable by interdiffusion of nickel and iron. Since these two principal interacting elements are unlimitedly soluble in each other without formation of intermetallic compounds and since nickel, a plastic metal, has a coefficient of linear thermal expansion only slightly higher ( $\alpha_{Ni} = 13.5 \cdot 10^{-6}/^{\circ}\text{C}$ ) than that of iron ( $\alpha_{Fe} = 11.5 \cdot 10^{-6}/^{\circ}\text{C}$ ), diffusion welding of a nickel-base coating to steel is technologically feasible. It is the diamond phase in the coating which limits the process. Since the resistance of synthetic diamond to graphitization and to oxidation is low, diffusion welding requires a vacuum or a protective atmosphere of an inert gas and must occur at a temperature not higher than  $650^{\circ}\text{C}$ . It is also desirable to dehydrogenize the nickel, most readily at  $350-400^{\circ}\text{C}$ , so as to facilitate complete stress relief at  $600-650^{\circ}\text{C}$ . The effectiveness of these procedures was tested on guide rollers made of 45 carbon steel and of 40Kh chromium steel hardened to HRC 48-50, U8 tool steel hardened to HRC 58-62, and Sch21-41 cast iron. The galvanic coatings were 0.5 mm thick and consisted of nickel with AS 15 400/315 diamond powder. Specimens cut from rollers were heat treated in a furnace at  $250-300^{\circ}\text{C}$ ,  $450-500^{\circ}\text{C}$ ,  $600-650^{\circ}\text{C}$  for 1-2-3-4-6-8-10 h. Metallographic examination under an MIM8-M microscope with x800 magnification and microstructural examination by x-ray micro-spectral analysis revealed an initial martensitic steel with an even steel-coating interface. Annealing at  $450-500^{\circ}\text{C}$  for 1 h was found to alter the microstructure of the steel base without altering the microstructure of that interface. Annealing at  $500^{\circ}\text{C}$  for 10 h was found to facilitate interdiffusion of nickel and iron, but only to a depth smaller than  $1 \mu\text{m}$  and thus hardly detectable. Effective interdiffusion to a depth of  $6 \mu\text{m}$ , sufficient for ensuring strong bond, required annealing at  $600^{\circ}\text{C}$ . In the case of cast iron, on the other hand, effective interdiffusion was found to occur already at  $450-500^{\circ}\text{C}$  with nickel replacing graphite lamellas in the base material. Accordingly, proper annealing of coated rollers can reduce their failure rate from the present 20% level for unannealed ones. References 6: 4 Russian, 2 Western (1 in Russian translation).

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# INFLUENCE OF ELECTRON BOMBARDMENT ON PHOTOELECTRIC PROPERTIES OF p-n JUNCTION BASED ON Ge-Si SOLID SOLUTION

Moscow NEORGANICHESKIYE MATERIALY in Russian No 10, Oct 85  
(manuscript received 30 Nov 83) pp 1625-1627

[Article by A. K. Abiyev and R. V. Shakhbazova]

[Abstract] Results are presented from a study of the effect of electron bombardment on the photoelectric properties of p-n junctions based on a Ge-Si system solid solution. The diffusion of antimony into p-type crystals with initial hole concentration  $10^{14} \text{ cm}^{-3}$  created p-n junctions. The thickness of the diffusion n-layer plus the space charge area was 2-2.5  $\mu\text{m}$ . The base area of the junction had a specific resistance of 1 ohm  $\cdot$  cm; its thickness was 300  $\mu\text{m}$ . A flux of accelerated electrons with an energy of 3 MeV bombarded the p-n junctions at room temperature. It was found that when p-n junctions based on a single crystal of Ge-Si solid solution were bombarded with a flux of accelerated electrons the photocurrent and photo-emf was decreased. However, the photocurrent decreased more than did the photo-emf, a result of the change in life time of secondary carriers in the base area of the junction. When bombarded p-n junctions were annealed, the photoelectric characteristics were partially restored. References 10: 7 Russian, 3 Western.

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CSO: 1842/64

# STATE DIAGRAMS OF CROSS-SECTIONS $\text{Tl}_2\text{S}(\text{Se})$ - $\text{GeS}(\text{Se})$ IN TRINARY SYSTEMS $\text{Tl}$ - $\text{Ge}$ - $\text{S}(\text{Se})$

Moscow NEORGANICHESKIYE MATERIALY in Russian No 10, Oct 85  
(manuscript received 2 Feb 84) pp 1645-1648

[Article by M. B. Babanly, N. A. Kuliyeva, Yu. A. Yusibov and R. F. Gasanov, Azerbaijan State University imeni S. M. Kirov]

[Abstract] Methods of differential-thermal and x-ray phase analysis plus measurement of microhardness and emf at 300-430 K are used to study the interaction in the  $\text{Tl}_2\text{Se}$ - $\text{GeS}$  and  $\text{Tl}_2\text{Se}$ - $\text{GeSe}$  cross sections of concentration circuits such as  $\text{Tl}(\text{solid}) \mid \text{glycerine} + \text{KCl} + \text{TlCl} \mid (\text{Tl}_2\text{Se})_x (\text{GeSe})_{1-x} (\text{solid})$ . It is found that the cross sections are nonquasibinary. Below the solidus the  $\text{Tl}_2\text{S}$ - $\text{GeS}$  cross section is unstable and intersects five 3-phase areas, while the  $\text{Tl}_2\text{Se}$ - $\text{GeSe}$  cross section is stable. Interaction of  $\text{Tl}_2\text{Se}$  with  $\text{GeSe}$  forms a trinary compound  $\text{Tl}_2\text{GeSe}_2$ . References 12: all Russian.

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## STUDY OF THE SYSTEM GeTe-PbSe

Moscow NEORGANICHESKIYE MATERIALY in Russian No 10, Oct 85  
(manuscript received 20 Feb 84) pp 1664-1669

[Article by N. Kh. Abrikosov, Ye. S. Avilov, O. G. Karpinskiy, O. V. Radkevich and L. Ye. Shelimova, Institute of Metallurgy imeni A. A. Baykov, USSR Academy of Sciences

[Abstract] A study is made of phase equilibria in the system GeTe-PbSe, and the influence of cation-anion substitution on the structural state, phase transition temperature and electrophysical properties of alloys of a solid solution based on  $\alpha$ -GeTe is also studied. Phase equilibria are studied in the ternary system  $\text{GeTe}+\text{PbSe} \leftrightarrow \text{GeSe}+\text{PbTe}$  at lower temperatures than in previous works. After annealing at 570 K, the alloys obtained were studied by thermal, microstructural, x-ray phase and dilatometric analysis. Conductivity and Hall coefficient at 300 K were measured by an ac potentiometer. The cross-section  $\text{Ge}_{0.98}\text{Te}-\text{PbSe}$  is quasibinary only at temperatures close to the solidus where there is a continuous series of solid solutions. As the temperature drops, complex transformations occur which are related to the polymorphism of germanium telluride and the formation of the ternary compound  $\text{GeSe}_{0.75}\text{Te}_{0.25}(\epsilon)$ . The crystallochemical specifics of solid solutions with cation and cation-anion substitution are studied in comparison to solid solutions with anion substitution. The influence of the addition of superstoichiometric tellurium on the  $\alpha$ - $\beta$ -phase transition temperature and the electrophysical properties of the solid solution based on  $\alpha$ -GeTe is demonstrated. References 8: 5 Russian, 3 Western.

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## THE SYSTEM SnTe-InSe

Moscow NEORGANICHESKIYE MATERIALY in Russian No 10, Oct 85  
(manuscript received 14 Feb 84) pp 1670-1672

[Article by A. P. Gurshumov, A. S. Aliyev, N. A. Mamedov, M. A. Alidzhanov and T. G. Gadzhiyev, Azerbaijan Construction Engineering Institute]

[Abstract] A study is made of the interactions and physical-chemical properties of alloys in the system SnTe-InSe. Specimens in the cross-section SnTe-InSe were prepared in quartz ampules evacuated to  $10^{-2}$  Pa with subsequent annealing at 720 K for 240-250 hours slightly below the solidus temperature established by thermographic analysis of nonannealed alloys.

DTA and x-ray phase analysis were then performed. The SnTe-InSe system is a quasibinary cross-section of the quaternary system Sn-In-Te-Se. The incongruently melting compound SnInTeSe and solid solutions based on the initial components are formed. References 5: 4 Russian, 1 Western.

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UDC: 537.226.4+666.655

#### SOLID SOLUTIONS WITH POTASSIUM-TUNGSTEN BRONZE STRUCTURE

Moscow NEORGANICHESKIYE MATERIALY in Russian No 10, Oct 85  
(manuscript received 8 Aug 83) pp 1803-1805

[Article by A. Ya. Dantsiger, R. U. Devlikanova, S. V. Gavriyachenko and V. P. Zav'yalov, Rostov-Na-Donu State University; Scientific Research Institute of Physics]

[Abstract] Specimens of the system  $K_2Pb_4Nb_{10}O_{30}$ - $K_6Li_4Nb_{10}O_{30}$  are obtained and studied. Compounds and solid solutions were obtained by solid-phase reactions. Specimens of high density ceramic were prepared by hot pressing at 20-40 MPa. The mean density of specimens, determined by hydrostatic weighing, was 99.5% of the theoretical. The symmetry and parameters of the unit cell of the synthesized compounds was established from powder radiographs measured on a diffractometer. Reorientation of domains other than  $180^\circ$  domains is possible in the P-phase of the system. As concentration of  $K_2Pb_4Nb_{10}O_{30}$  increases in the P-phase,  $\delta$  increases, leading to a decrease in  $\eta$ . A sudden change in spontaneous deformation is found to have a decisive role in the formation of the extremes of electrophysical parameters. References 4: all Russian.

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UDC 536.421

#### STRUCTURE AND MORPHOLOGY OF METAL AND SEMICONDUCTOR FILMS GROWN IN ZONE OF LASER BEAM AND SUBSTRATE INTERACTION

Moscow POVERKHNOST' in Russian No 11, Nov 85 (manuscript received 6 Feb 84)  
pp 54-57

[Article by A. G. Bagmut and A. A. Sokol, Kharkov Polytechnic Institute]

[Abstract] A study of periodic surface structures produced by optical interference effects during laser treatment of metals and semiconductors,



specifically gold, antimony, and  $\text{Sb}_2\text{S}_3$ , was made for establishing the feasibility of such a technology. Nonpolarized radiation from a Nd-YAG laser (wavelength  $\lambda = 1.06 \mu\text{m}$ ) emitting giant pulses (approximately 2 MW) of approximately 10 ns duration at a repetition rate of 25 Hz was led through a sapphire window into a vacuum chamber with a residual pressure adjustable over the  $10^{-4}$ - $10^{-5}$  Pa range. Here the laser radiation was passed through a focusing lens and a transparent substrate onto the target (Au, Sb,  $\text{Sb}_2\text{S}_3$ ), the temperature of the substrate being maintained at 20-22°C during treatment and its orientation relative to the incident laser beam being adjustable by means of a goniometer screw. Films of the target materials were deposited from their vapor phase on the "back" surface of orienting substrates such as KCl(001) chips in air and on nonorienting substrates such as glass. The "splash" effect was minimized by scanning the target surface, with the laser beam fixed and the target moved around. The films were peeled off substrates for examination under a transmission electron microscope and electron diffractometry, a thin fine-disperse KCl interlayer deposited on glass before a film of Au, Sb, or  $\text{Sb}_2\text{S}_3$  facilitating the removal of that film from the glass substrate. The results of this examination indicate the feasibility of producing films of those materials with periodic thickness modulation by this process, the period of such a film structure depending on the angle of laser beam incidence (substrate orientation) but not on the substrate material. The authors thank V. M. Kosevich for discussion of the results obtained. References 7: 3 Russian, 4 Western.

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UDC 539.2

# EPITAXIAL COPPER AND CHROMIUM COATINGS ON (111)-PLANE SURFACE OF MOLYBDENUM SINGLE CRYSTAL

Moscow POVERKHNOST' in Russian No 11, Nov 85 (manuscript received 9 Jan 84, in final version 21 May 84) pp 79-83

[Article by L. M. Gert, D. S. Gornyy, N. P. Dubinin, V. B. Kanikovskiy and L. R. Yushina]

[Abstract] Epitaxial coatings of copper (f.c.c. crystal lattice), chromium (b.c.c. crystal lattice), and copper with chromium sublayer on single crystals of molybdenum (b.c.c. crystal lattice) was studied for a comprehensive analysis of epitaxial interaction between copper and molybdenum, specifically in the (111)-plane of Mo single crystals characterized by no physico-chemical interaction and minimal crystallographic mismatch between them. Coatings were deposited by vacuum evaporation from crucibles heated by electron bombardment, MOB copper from a molybdenum crucible and 99.9% pure chromium from a crucible made of boron nitride. The substrate temperature was varied over the 200-700°C range. The coating thickness was varied over



the 5-40  $\mu\text{m}$  range for copper and over the 4-6  $\mu\text{m}$  range for chromium, and was fixed at 1/7  $\mu\text{m}$  for the Cr/Cu combination. The deposition rate was varied over the 1.0-22.5 nm/s range for copper, fixed at 1.8 nm/s for chromium, and fixed at 1.8/22.5 nm/s for the Cr/Cu combination. The (111)-plane surface of Mo single crystals was electrically polished for removal of the defective top layer after mechanical polishing. The coatings were analyzed by Laue x-ray diffractometry with a  $\text{CuK}_\alpha$ -radiation source. The results reveal that the substrate temperature for epitaxial buildup of coatings is 600°C for copper and 400° for chromium or the Cr/Cu combination. They thus also indicate that, contrary to predictions based on purely geometrical relations, a chromium sublayer does facilitate epitaxial molybdenum-copper interaction and lowers the temperature of epitaxial buildup for copper by 200°C. References 3: 2 Russian, 1 Western.

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UDC 535.34:539.211

# EFFECT OF THIN SILVER LAYERS ON ABSORPTION OF SURFACE ELECTROMAGNETIC WAVES BY ORGANIC FILM ON METAL

Moscow POVERKINOST' in Russian No 11, Nov 85 (manuscript received 4 Jan 84)  
pp 115-118

[Article by G. N. Zhizhin, A. A. Sigarev and V. A. Yakovlev, Spectroscopy Institute, USSR Academy of Sciences, Troitsk]

[Abstract] Absorption of surface electromagnetic waves by an organic film on metal substrate and changes in the absorption spectrum upon buildup of thin silver layers on top of that organic film are analyzed on the basis of theoretical realtions and experimental data. The theoretical model is a structure consisting of two intermediate layers of different thicknesses between two semiinfinite media, metal and air, each of the four having a different dielectric permittivity. The corresponding complex nonlinear equation of dispersion is solved by expansion of the wave vector into a series in the thicknesses of both films as small parameters. Only linear and quadratic terms need to be retained to ensure adequate accuracy for the given system. The available experimental data pertain to a film of 4-n-octadecyl phenol consisting of three  $25.4 \pm 0.2$  Å thick monolayers deposited on copper by the Langmuir-Blodgett method and 2 Å thick silver layers successively deposited up to a 50 Å total thickness on top. Calculation of the SEW absorption spectrum in terms of optical density reveals that increasing the thickness of the silver coating increases the phononic absorption of surface electromagnetic waves. These results are useful for study of thin metal films in metal-dielectric-metal systems. The authors thank V. I. Troitskiy for recommending how to produce (4-n-octadecyl phenol) films and how to make electron diffraction measurements, also V. A. Sychugov and A. A. Khakimov for producing the arrays on substrates, and G. S. Stankevich for synthesizing 4-n-octadecyl phenol. References 7: 2 Russian, 5 Western.

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UDC 621.793.724:666.233

CHARACTERISTICS OF CHEMICAL COATING FORMATION ON DIAMONDS

Kiev SVERKHTVERDYIE MATERIALY in Russian No 5, Sep-Oct 85  
(manuscript received 2 Jul 84) pp 32-35

[Article by T. M. Duda, V. N. Tkach and G. P. Bogatyreva, Institute of Superhard Materials, UkSSR Academy of Sciences, Kiev]

[Abstract] A special study of nickel coating electrochemically deposited on synthetic abrasive diamond grains was made for the purpose of establishing a consistent theory and resolving the apparent contradictions in data already available. The metallization process requires chemical recovery of nickel from its salt, with the metal inclusions in synthetic diamond grains acting as catalysts while forming a sublayer on the grain surface and salts of lead or precious metals (Pd, Ag, Pt, Au) used as sensitizers. Diamond powders AS 2, AS 6, AS 15, ASM 1/10 with their surface cleared of all contaminants including metallic ones by treatment with  $H_2SO_4$  and  $H_2CrO_4$ , were examined in a "Camebax" x-ray spectral microanalyzer by the neutron-activation method, for a quantitative determination of Ni, Cr, Mn, Fe, Co inclusions in those powders and of their surfacing. The results indicate that the rate of nickel coating deposition on a metal sublayer does not depend on the grade, the grain fraction, and the mass of the diamond powder. It does increase with increasing concentration of nickel salt and with increasing surface area for the chemical reaction. A further study of the process has also revealed that the metallization rate depends intricately on the concentrations of the principal reactants in the solution as well as on the pH and the temperature of the latter. The data are so consistent that they can serve as basis for optimizing and speeding up the chemical metallization of diamond powders. References 4: 3 Russian, 1 Western.

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## DETERMINATION OF CHEMICAL COMPOSITION OF CONDENSATES BASED ON METALS AND ALLOYS OBTAINED FROM ARC DISCHARGE PLASMA IN A VACUUM

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 5, Sep-Oct 85  
(manuscript received 17 Apr 84) pp 103-106

[Article by V. A. Bocharov, V. L. Rossoshansk, V. P. Samoylov and  
N. P. Titova, Khar'kov]

[Abstract] Differences in the chemical composition of cathodes made of pure copper, chromium and molybdenum, as well as of stainless steel and a copper-nickel-zinc alloy, and of condensates obtained from these cathodes from an arc discharge plasma are found to arise as a result of mass transfer. Condensates were obtained on glass substrates measuring 9 x 12 cm. The condensates are slightly enriched with impurities. Condensates obtained from alloys containing volatile substances with high vapor tension are impoverished in the volatile components. X-ray phase analysis can be used to provide a quantitative analysis of the chemical composition of the condensates. Corrections must be introduced for the mutual influence of the elements if thicknesses differ greatly. References 8: all Russian.

6508/9835

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## METALLIZATION OF DIAMONDS BY CHEMICAL TRANSPORT REACTIONS IN TRANSITION METAL HALIDE GAS PHASE

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 5, Sep-Oct 85  
(manuscript received 10 Oct 83) pp 107-110

[Article by A. I. Yevstyukhin, I. I. Gavrilov, V. F. Grishachev and  
V. P. Maslov, Moscow]

[Abstract] Metallization of diamonds by chemical transport reactions in the gas phase of transition metal halides is studied. Thermodynamic analysis of possible reactions of metal precipitation was undertaken in order to estimate the parameters of the process. Computer calculations of the equilibrium composition of the gas phase in the system transition metal-carbon-halogen was performed, considering the possibility of formation of a carbide coating on the diamond. It is shown that the formation of transition metal carbide coatings on diamonds from the gas phase of chlorides or iodides is thermodynamically possible at temperatures below 1000°C under conditions eliminating graphitization of the diamonds. It is experimentally shown that at certain temperatures coatings of transition metal carbides are indeed formed on

diamond surfaces and graphite is not detected. The limiting stage of formation of the coatings is diffusion of carbon atoms in the solid phase. References 12: 11 Russian, 1 Western.

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CSO: 1842/65

UDC: 669.55'787:539.23:535

#### INFLUENCE OF ANNEALING ON OPTOGEOMETRIC PARAMETERS OF THIN ZINC OXIDE FILMS

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 5, Sep-Oct 85  
(manuscript received 27 Jul 84) pp 115-118

[Article by N. Belov, M. Bertolotti, Ye. Verona, A. Pal'ma, D. Sette, F. Ferrari and A. Yas'kov, Leningrad, Rome]

[Abstract] The purpose of this work was an experimental study of the index of refraction or effective wave mode refractive index as well as waveguide losses in a film as a function of the conditions of thermal and laser annealing. Thin films of ZnO were applied by radio frequency atomization onto glass or preoxidized silicon substrates. Thermal annealing was performed in air at 400-600° for 0.5-4 hr. Laser annealing was also performed in air with a continuous CO<sub>2</sub> laser by scanning of the surface with a focused beam or by irradiation of the specimen surface with an unfocused beam. The results indicate that compacting of the layer on the surface occurs during both thermal and unfocused laser annealing. During focused laser annealing the interaction is short term and occurs in the surface layer at the film-substrate interface. The film structure therefore does not change. References 5: all Western.

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#### THIN FILMS OF ZINC TELLURIDE FOR OPTOELECTRONICS

Moscow NEORGANICHESKIYE MATERIALY in Russian No 10, Oct 85  
(manuscript received 30 Jan 84) pp 1795-1796

[Article by O. L. Sagaydak, M. S. Vinogradov and D. L. Vasilevskiy, Odessa State University]

[Abstract] A method has been developed for producing low resistance photo-sensitive ZnTe layers, the method being a synthesis of the three temperatures



method and the quasi-closed volume method. Layers are precipitated on glass substrates in a heated, quasisealed chamber with independent sections for the initial components. The growth rate is 0.5-1.0  $\mu\text{m}/\text{min}$ . Crystal dimensions are comparable to the film thickness. The photoconductivity spectra of the films indicated a broad area of impurity sensitivity. The method allows production of ZnTe films suitable for the creation of effective photoelectric devices based on ZnSe-ZnTe and ZnTe-CdSe heterojunctions. References 4: all Russian.

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UDC 621.793.7:621.9.65.015.13

#### PROBLEMS IN DESIGNING TECHNOLOGICAL PROCESSES FOR GAS-FLAME SPRAY DEPOSITION OF COATINGS

Moscow SV'AROCHNOYE PROIZVODSTVO in Russian No 10, Oct 85 pp 20-22

[Article by Yu. A. Kharlamov, candidate of technical sciences, Voroshilovgrad Machine Building Institute]

[Abstract] The system "input"- "output" concept is applied to design of manufacturing processes for the gas-thermal spray deposition of coatings. There are 14 "inputs" considered here: 1. the material of the coated part and the method of its production, determining its technological as well as physico-mechanical characteristics; 2. the shape and size of the coated part; 3. the technical capabilities of the manufacturing facilities; 4. reliability of the manufacturing facilities; 5. characteristics of the cutting tool or agent; 6. processing conditions; 7. treatment modes and sequence; 8. organizational and technical factors; 9. surface finish; 10. the coating material and its properties; 11. characteristics of the two-phase spray jet within the coating zone, determined by process performance requirements; 12. ambient medium; 13. characteristics of the deposited coating; 14. impregnating material and its properties. These "inputs" are assigned to the three process stages: A. preparation of coated part ("inputs" 1-8); B. gas-thermal spray deposition ("inputs" 1-4, 6-8, 9-12); C. treatment of the deposited coating ("inputs" 1-8, 12-14). There are 4 system "outputs" considered here: I. quality of the deposited coating; II. precision of coating deposition and post-treatment; III. productivity of the coating post-treatment; IV. cost effectiveness of the coating post-treatment. On the basis of these criteria a route chart for the process is constructed, which is now subdivided into five stages: I. special surface pretreatment by any of 9 available methods; II. deposition of undercoating layer by any of 12 available methods; III. gas-thermal deposition of coating by any of these 12 available methods; IV. special post-treatment of the deposited coating by any of 5 available methods; V. machining of coated part by any of 3 available methods also applicable to surface pretreatment. The standard 7-step design procedure (data analysis and preparation - preliminary design - logical



evaluation of all possible design variants and selection of acceptable ones - dimension analysis and design refinement - cost and reliability analysis - finalization of optimum design variant - pilot production) is followed, with provisions for the use of relevant industrial and experimental-engineering "input" information. References 5: 4 Russian, 1 Western (in Russian translation).

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#### FACILITY FOR GAS-FLAME SPRAY COATING OF REFRACTORY MATERIALS BY THE POWDER METHOD

Moscow SVRAOCHNOYE PROIZVODSTVO in Russian No 10, Oct 85 pp 22-23

[Article by Ye. V. Govorin, candidate of technical sciences, and Yu. L. Yudushkin, engineer, All-Union Scientific Research and Design Institute for Autogenous Machine Building]

[Abstract] A facility has been developed at the All-Union Scientific Research and Design Institute for Autogenous Machine Building and is now produced at the Barnaul Equipment and Machinery Plant for gas-flame spray coating of refractory materials by the powder method. The primary objective in the design of this facility was to maximize productivity of the coating process and utilization of the coating material while also minimizing the gas consumption. It is designed to produce high-quality coatings of friable and not so friable materials not only flat parts but also on cylindrical and conical as well as spherical parts made of materials melting at temperatures up to 2050°C. The equipment consists of a burner-nozzle assembly and three feeders, one for alumina powder including nonspheroidized particles and two for self-fluxing powder or other nearly spherical powder particles respectively, at nominal or maximum delivery rate. The gas nozzles of the burner form a concentric circle around the tube at the center from which powder is injected into the flame through any one of three interchangeable special-purpose mouthpieces for different powders. Uniform powder delivery is ensured by its forced feed into the dynamic pressure zone of the gas jet, which requires different dimensioning of the three feeders.

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CSO: 1842/70

## PURIFICATION OF COMPRESSED AIR FOR GAS-FLAME SPRAY DEPOSITION

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 10, Oct 85 p 28

[Article by V. A. Budayev, candidate of technical sciences, Ya. V. Khusainov, candidate of technical sciences, A. N. Skachkov, engineer, L. A. Belkhoroyev, engineer, and P. S. Ukhanov, candidate of economic sciences, Syzran branch, Kuybyshev Polytechnic Institute]

[Abstract] A device has been developed for purging compressed air of liquid impurity, which is necessary for ensuring the production of high-quality coatings by gas-thermal spray deposition. It consists of 100 mm long and 3 mm thick tubular metal filters with an outside diameter of 40 mm, having a total active filtering surface area of  $0.09 \text{ m}^2$ , and a total capacity of approximately  $10 \text{ dm}^3$ . These filters are produced by compacting and sintering a mixture of steel and copper powders into a porous structure. With a pore diameter of  $80\text{--}100 \text{ }\mu\text{m}$ , the filter walls can withstand pressures of  $1.0\text{--}1.5 \text{ MPa}$ . With a pressure drop of  $6 \text{ kPa}$ , these filters can process air at rates of  $0.8\text{--}1.3 \text{ m}^3/\text{min}$ . The mechanism of air purification is based on enlargement of liquid mist upon contact with porous walls and formation of a liquid film or large drops which are then removed by the force of gravity. Prototypes of this device have successfully passed factory tests for use with KDM gas-thermal coating equipment.

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CSO: 1842/70

UDC: 620.18:621.785.532:621.787.044

## INFLUENCE OF NITRIDING TEMPERATURE IN GLOW DISCHARGE ON THICKNESS AND COMPOSITION OF NITRIDE ZONE

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 11, Nov 85, pp 23-27

[Article by N. N. Martovitskaya and T. S. Tonchev, Bulgaria]

[Abstract] A study is made of the influence of nitriding temperature in pure ammonia and carbon-containing glow discharge plasmas on the thickness and composition of the nitride zone on 18KhGT, 45 20Kh, 40 Kh and 38KhMYuA steels. Nitriding in  $\text{NH}_3$  was performed on 45, 40Kh, 38KhMYuA steels for two hours at  $400\text{--}750^\circ\text{C}$  with cooling in air. Nitriding at over  $600^\circ\text{C}$  results in a significant decrease in the intensity of the diffraction lines of the nitride phases, particularly for types 45 and 40Kh steels. As the temperature in the glow discharge is increased, the thickness of the zone of chemical compounds increases, reaching its maximum at  $600^\circ\text{C}$ , at which point the

the quantity of  $\epsilon$ -phase in the nitride zone decreases, while the  $\gamma'$ -phase increases. At over 600°C in ammonia and carbon-containing media the zone of chemical compounds is practically not formed. The variation of the composition and thickness of nitride layer as a function of temperature under saturation conditions in a glow discharge differs significantly from the variation of the analogous properties in a layer obtained by nitriding by the classical method. References 11: 3 Russian, 1 Bulgarian, 1 Rumanian, 6 Western.

6508/9835  
CSO: 1842/86

UDC: 621.785.53:661.65:669.14.018.29

#### INFLUENCE OF BORIDING ON THERMAL EMF OF CARBON STEEL

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 11, Nov 85, pp 27-29

[Article by Ye. V. Shadrichiev and E. A. Surov, Northwestern Correspondence Polytechnical Institute]

[Abstract] The purpose of this work was to determine the correlation between thermal emf and structural parameters of a boride layer. Studies were performed on specimens of types 20, 45 and U8A carbon steels 6 mm in diameter and 15 mm in length. Saturation was performed in borax melts with boron carbide and silicon carbide. Boriding was performed at 850 and 950°C with holds of 0.5-5 hrs, yielding boride layers of varying thickness and phase composition. Cooling was in air. The data obtained are mathematically processed by the least squares method to yield a third power polynomial expressing the variation of thermal emf as a function of boride layer thickness. The equation can be used to develop a thermoelectric method of determining the thickness of the boride layer in carbon steels. References 12: 10 Russian, 2 Western.

6508/9835  
CSO: 1842/86

DISTRIBUTION OF DIAMONDS IN COMPOSITE MATERIALS FOR ROCK CRUSHING TOOLS

Kiev SVERKHTVERDYIE MATERIALY in Russian No 5, Sep-Oct 85  
(manuscript received 20 Mar 84) pp 24-29

[Article by A. L. Maystrenko, V. N. Kulakovskiy, E. S. Simkin and  
N. V. Tsylin, Institute of Superhard Materials, UkSSR Academy of Sciences,  
Kiev]

[Abstract] A stereological analysis of tungsten-base composite materials with diamond content for rock crushing tools was made, the purpose being to determine the size distribution of diamond grains and other geometrical parameters of the diamond phase such as grain cross-section area and intergranular distance. Specimens of these materials were produced by mixing a tungsten alloy with natural diamond ("slavutich") and with synthetic diamond ("tvesal") in amounts ranging from 0.187 vol.% to 0.438 vol.% (75-175% according to GOST 9770-51 All-Union State Standard) of the 400/315 grain fraction, or with 0.25 vol.% of grain fractions ranging from 250/200 to 630/500. Microsections were enlarged on a ChP-2 clock projector with x50 magnification and the enlargements were photographed for automatic data processing by a "Kvantimet-720" image analyzer. Subsequent analysis of the geometrical relations and the statistical distributions has yielded a fairly reliable semiempirical relation between the effective diameter  $\bar{d}$  and the concentration  $C_1$  of each particular diamond grain fraction which will ensure continuous surface coverage:

$$C_1 = -0.0159\left(\frac{2}{\bar{d}}\right) + 0.438, \text{ accurate within}$$

0.8% for  $0.2 \leq \bar{d} \leq 0.6$  mm and  $0.25 \leq C_1 \leq 0.4$  vol.%. The authors thank N. M. Fonshteyn and A. N. Bortsov at the Central Scientific Research Institute of Ferrous Metallurgy for cooperation in making this study as well as A. A. Bugayev and V. D. Andreyev at the Institute of Superhard Materials (UkSSR Academy of Sciences) for helpful comments on its results.  
References 14: 13 Russian, 1 Western (in Russian translation).

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CORROSION RESISTANCE OF DIAMOND-METAL COMPOSITES

Kiev SVERKHTVERDYIE MATERIALY in Russian No 5, Sep-Oct 85  
(manuscript received 25 Jun 84) pp 17-20

[Article by E. D. Kizikov, V. P. Chepeleva, L. M. Novikova and S. Yu. Len,  
Institute of Superhard Materials, UkSSR Academy of Sciences, Kiev]

[Abstract] Since diamond-metal composites are used in equipment of the chemical industry, for pulverization of organic materials such as wood and rags, their corrosion resistance has become an important factor in tool design for adequate length of service life. For an experimental evaluation of that corrosion resistance, specimens of five special powder-metal bronzes were produced with a surface roughness not exceeding  $R_a = 0.8 \mu\text{m}$  and containing respectively 10.0 wt.% Ti, 7.5 wt.% Ti + 2.2 wt.% Ni, 22.5 wt.% Ti + 6.6 wt.% Ni, 37.5 wt.% Ti + 11.0 wt.% Ni, 72.5 wt.% Ti + 25.5 wt.% Ni. Each was tested as is and then mixed with AS 20 synthetic diamond powder of 50/40, 125/100, 160/125, 315/250 grain fractions in either 75:25 or 50:50 ratio of bronze powder to diamond powder. The corrosion of the bronzes and the composites was measured by the continuous gravimetric method according to GOST 13819-68 All-Union State Standard, in a neutral medium ( $\text{pH} = 7$ ), in an acidic medium (aqueous solution of  $\text{H}_2\text{SO}_4$  with  $\text{pH} = 5$ ), and in an alkaline medium (aqueous solution of  $\text{NaOH}$  with  $\text{pH} = 9$ ) at room temperature for 24-48-100-250 h. These tests simulated operating conditions for circular knives and grinding wheels. The results reveal that the corrosion resistance of all five bronze alloys stabilizes within 100 h at an adequate level in all three media. It remains high and independent of the grain size when diamond powder is added in the smaller amount, but decreases when diamond powder is added in the larger amount. The corrosion resistance is evidently determined by the porosity of the material. References 2: both Russian.

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FERROUS METALS

CHEREPOVETS COMBINE RECEIVES AUTOMATION EQUIPMENT

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 21 Nov 85 p 1

[TASS article "An Order on Time"]

[Text] An order for the country's largest blast furnace, the Severnyak, being built at the Cherepovets Metallurgical Combine, has been filled by the collective of the Kharkov Association for Automated Control Systems. It has shipped the last consignment of automated control system equipment for the giant furnace.

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CSO: 1842/82

## METALLURGICAL PLANTS EXCEED PLANS

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 21 Nov 85 p 1

[Article by V. Ukolov, staff correspondent, in Ustinov: "Speeding-up at the Finish"]

[Text] Metallurgists of the Izhstal association in Ustinov and at the Kirovskiy Zavod association in Leningrad have quickened the pace at the finish of the final year of the 11th Five-Year Plan. Competing against each other, they are preparing a worthy welcome for the 27th CPSU Congress. For example, the steel makers of the new open hearth shop, defending the honor of Urals workers, instead of a 1,000 tons of metal above the plan, produced twice as much to fulfill their obligations; they also reduced costs per ruble of commodity output and saved more than 120,000 rubles. They fulfilled 100% of their contracts for delivery of goods.

And what were the Leningrad workers' successes? They reported early fulfillment of their socialist obligations for the 11th Five-Year Plan, having melted 1,000 tons of metal beyond the plan.

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CSO: 1842/82

## CONSTRUCTION DELAYS AT KAMYSHIN PLANT CAUSE DIFFICULTIES

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 21 Nov 85 p 2

[Article by I. Mordvinets, staff correspondent, in Kamyshin and Vologograd: "Ruination From Dispersal: Commentary on the Secretary of the Kamyshin Forge and Foundry Plant Party Committee's Report"]

[Text] Party Committee Secretary A. Vasilyev presented some disturbing data in his report at the report and election meeting of the Kamyshin Forge and Foundry Plant's communists. For every ruble spent to produce an item, the enterprise's collective takes almost two out of the Government's pocket. And this destructive tendency is by no means diminishing. This year, for example, expenditures rose no more or less than another 20 kopeks.

Let it be expensive, as long as it's good. But customers are literally moaning. Here's what I happened to hear from the director of the Volgograd Motor Plant, V. Shiryayev:

"If only our partners would stay within just 10 percent rejects! But, as it is now, every blank they send is an enigma. The machinist makes a part from it, and it's like a sieve. We've gone to the suppliers and complained to the local Gosstandard authorities, but the situation doesn't change..."

You'll agree that it's hard to reconcile this with elementary logic. According to all the rules, a product from a very new enterprise which is supposed to set the standard for technical progress in blank production for the Ministry of Tractor and Agricultural Machine-Building should be manufactured with maximum efficiency, minimum cost, and highest quality. Otherwise, why make a fuss?

But how did this newly built enterprise end up so insolvent, both technically and economically? Without attempting an exhaustive analysis of the reasons, let us consider the one which everyone mentions first. That is, how the Kamyshin Forge and Foundry Plant was and still is being built.

Both the plant and the Ministry of Tractor and Agricultural Machine-Building complain that the general contractor, the Kamyshinpromzhilstroy Trust, doesn't have the capability to erect such a large enterprise. The truth is



apparently indisputable. In fact, in the entire present five-year plan, the trust will use a bit more than 100 million rubles at the plant. According to the calculations of Chief Engineer Yu. Stal'gorov, the plant would have to hand over that much every year to confidently create even marginally efficient start-up facilities.

The client is clearly displaying an excessive, one can even say, even uncontrollable, appetite for capital investment. Construction of a huge iron foundry has been going on here at this site since 1972. And 5 years later, when the foundry was half finished, it was "put on ice," and construction of the hot-forging shop moved from "ground zero". A few years later, the Ministry of Tractor and Agricultural Machine-Building suddenly decided to continue construction of both these huge facilities. And they are still going up somehow, despite the extreme lag in all ancillary services.

In the fourth quarter of this year, new capacities for 4,000 tons of forgings for use in the Don-1500 combine being mastered by Rostselmash should be handed over. Metallurgprokatmontazh is now doing the installation work here. Although it was late in starting, there is still a chance that start-up can take place before the end of the year. And in the iron foundry, where productive capacity for 30,000 tons of castings was scheduled to go into operation now, work is delayed, to a great extent the fault of the same plant personnel who didn't deliver equipment on time. And now they themselves are seeing to it that the start-up facility in the foundry is reduced.

"As of the beginning of the year," A. Vasilyev's report states, "Our deliveries to customers were 1,621,000 rubles short. The shortfall will increase in the fourth quarter."

The forge and foundry's managers intend to catch up by means of a very unoriginal approach--revising the plan at the end of the year. They know that this has recently become unpopular, but they still hope.

The fact is that the excessively long construction time has left its mark on the entire situation at the plant. As brigade-leader V. Zaytsev noted in his speech at the report and election meeting, the forging shop is experiencing extremely high downtimes even with the equipment already operational, and labor and technological discipline are low. And furnace operator V. Kotov noted also the poor monitoring of adherence to the production process and the lack of any monitoring whatsoever on night shift. Employee training is not organized as it should be. To judge from the general situation, many here have lost their faith that the enterprise will ever dig its way out of its hole.

But precisely who is to blame for the fact that the Kamyshin Forge and Foundry Plant is being built in fits and starts? No one, according to the managers of the plant and of the general contractor trust. There were simply some problems, and then some others arose. And they advise us not to worry about this sort of problem: decisions in these cases are made not by an individual, but collectively, and at a sufficiently competent level.

Let me boldly assert that their competence is rather questionable. "Pushing through" decisions to create productive capacities, the sector ministries are now only very approximately realizing how much the builders on the spot are capable of comprehending the ornate plans that have arisen in the industry's headquarters. Nevertheless, equipment is ordered and acquired, often by import. But when construction drags along, it isn't put into operation right away, and it gathers dust for years in warehouses, or even rusts in the open air. According to data from the local Stroybank office, equipment worth 350 million rubles has now piled up in Volgograd Oblast alone.

As stated at a recent plenum of the Volgograd CPSU Obkom, the second secretary of the Kamyshin City Party Committee, K. Yastrebov, has been severely punished for the low level of leadership of industry and construction. But this is small consolation. The need has arisen for organizational measures not to identify such failures, but to serve as a constant reminder that construction should not become an end in itself.

But let's go back to the Kamyshin Plant. There are two ways to speed up the protracted creation of this enterprise. One involves rapid development of the Kamyshinpromzhilstroy Trust's capacities. But, again, this requires building and augmenting the construction industry's own base, which at the trust is hopelessly behind schedule. Anyway, nothing has been done about this in the current five-year plan. It is true that the USSR Minpromstroy [Ministry of Industrial Construction] has now incorporated into the trust's plan work to rebuild its reinforced concrete products plant. However, it is scheduled for completion only by 1988.

Another possibility is to reduce the workload of the trust's subdivisions which now work at 360 sites, 200 of which are outside city limits. And in this the correspondent's viewpoint matches the opinion of competent workers. A. Makarov, manager of the oblast Stroybank office, sent a report to the Volgograd Party obkom in which he considers it absolutely urgent to completely stop construction of production facilities at the forge and foundry plant for a certain period so that the facilities which have already been built can be made operational. This involves first bringing up the rear--auxiliary shops, housing, the trolley line to the city, and building other social and cultural amenities.

But, alas, they simply ignored this opinion. At this same report election meeting, Party members learned that, in the next year or two, new facilities (of which there isn't even a trace yet) must produce their first output: powder metallurgy, steel-bronze strip, aluminum castings.

And how does the industry headquarters look at all this? I put this question to the deputy minister of the Ministry of Tractor and Agricultural Machine-Building, A. Skrebtsov, who was recently in Volgograd. Anatoliy Mikhaylovich agreed that the Kamyshin Forge and Foundry Plant desperately needs help, which, he says, it is receiving. Like what? "Well, we are strengthening the repair

and tool organizations there," comrade Skrebtsov explained. "We are trying to recruit experienced specialists from other foundries." The deputy minister had no comment on his position regarding comrade Makarov's report, a copy of which was sent to the Ministry of Tractor Agricultural Machine-Building.

And therefore, no barriers to the dispersal of the builders' forces are foreseen.

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INCREASING THERMAL STABILITY OF HIGH SPEED STEELS BY LASER ALLOYING

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 11, Nov 85 pp 2-6

[Article by V. A. Burakov, G. I. Brover and N. M. Burakova, Rostov-na-donu Plant-Higher Technical School attached to the Rostsel'mash Plant; Scientific Research Institute of the Technology of Automobile, Tractor and Agricultural Machine Building]

[Abstract] The combination of laser hardening with alloying using solid coatings preliminarily applied to the irradiated surface allows an additional source of saturation to be used, thus preserving concentration heterogeneity of solid solutions resulting from incomplete dissolution of carbide phases. New elements can also be included in the composition of the high speed steel, still further improving properties after hardening. Laser alloying with melting of the surface layer and hardening from the liquid state, achieved by applying laser radiation with a power density of over  $1.5 \text{ GW/m}^2$ , is found to be an effective means of improving the usage properties of high speed steels. Laser alloying R6M5 steel with cobalt plus tungsten yields the greatest thermal stability. References 4: all Russian.

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LASER ALLOYING OF U10 STEEL USING TUNGSTEN-BASED SURFACING POWDER

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 11, Nov 85 pp 6-8

[Article by V. Ye. Arkhipov and T. A. Smolonskaya, Remdetal All-Union Scientific-Production Association]

[Abstract] A study is made of the influence of various additives to a surfacing composite on the formation of the structure of the alloyed layers



and their quality. Primary attention is concentrated on the processes occurring in the melt. Oxidation by the oxygen in the air results in a significant decrease in the quality of the layer being formed. The microstructure of the transition layer and surfaced layers was studied on transverse sections in a light microscope at up to 1000 X magnification. Radiographic analysis was performed on a diffractometer. The nature of the coating structure and the distribution of alloying elements through the melted layer were studied on a Camebax micro-x-ray spectrometer. It was found that the introduction of silicon and boron carbide to the surfacing composition had a favorable influence on the structure and properties of the layers produced. Introduction of carbide compounds allowed broad variation of properties of the layers produced. The productivity of the process of laser tungsten coating is up to 160 cm<sup>2</sup>/hr and that of laser tungsten-boride coating--up to 90cm<sup>2</sup>/hr.

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#### SURFACE SATURATION OF STEEL WITH BORON UNDER THE INFLUENCE OF LASER RADIATION

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 11, Nov 85, pp 9-11

[Article by Yu. M. Lakhtin, Ya. D. Kogan and A. V. Buryakin, Moscow Institute of Vehicles and Roads]

[Abstract] A study is made of the influence of conditions of alloying of specimens of technical iron and type 40Kh steel with boron by pulsed laser radiation on the structure of the hardened zones, microhardness, ductility and wear-resistance. Preliminary heat treatment of the 40Kh steel consisted of hardening in oil from 860°C and high tempering to HRC 21-23. Before laser irradiation, a boron-containing covering was applied to the surface and then the surface was exposed to pulsed laser radiation. The change in structure and microhardness of the metal as a result of boron alloying in comparison to laser heat treatment alone occurred only in the melting zone. The content of boron in the melting zone is determined by the ratio of quantity of covering applied to the surface to volume of the bath of melted and rapidly crystallized metal. The phase composition and microhardness of laser hardened zones on steel treated with the boron coating was determined primarily by the quantity of boron-containing covering applied, laser radiation pulse energy and the position of focal plane of the output lens of the optical system with respect to the surface of the specimen. Boron alloying of the hardened zone helped to improve mechanical properties in comparison to laser heat treatment alone and is recommended for parts to be exposed to wear. References 4: all Russian.

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DETERMINATION OF CONDITIONS OF BORIDING OF STEEL UPON HEATING BY LASER RADIATION

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 11, Nov 85 pp 12-14

[Article by L. S. Lyakhovich, S. A. Isakov, V. M. Kartoshkin and V. P. Pakhadnya, Belorussian Polytechnical Institute; Mogilev Institute of Technology]

[Abstract] The purpose of this work was to determine the conditions for production of boride coatings on steels with heating by laser radiation. Studies were performed on an experimental installation including an up to 800W continuous CO<sub>2</sub> laser operating at 10.6  $\mu$ m and a 223 mm focal length KCl focusing lens. Coatings were obtained from type 45 steel, following preliminary annealing, by applying a layer of an aqueous suspension of black amorphous boron, drying of the layer and exposure of the surface to laser radiation. High quality boride layers 80-120  $\mu$ m thick were produced with a laser radiation density of 0.4 GW/m<sup>2</sup> and a specimen movement rate of 6-8 mm/s. The boride layer consists primarily of Fe<sub>2</sub>B and FeB. The structure and phase composition of the boride layer are primarily influenced by the thickness of the layer of amorphous boron applied to the surface of the specimen before laser radiation. References 7: all Russian.

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INFLUENCE OF LASER AND HEAT TREATMENT ON STRUCTURE AND PROPERTIES OF HIGH-CHROMIUM CAST IRON

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 11, Nov 85 pp 14-17

[Article by D. M. Gureyev, A. Ye. Zaykin and S. V. Yamshchikov, Kuybyshev Branch, Physics Institute imeni P. N. Lebedev, USSR Academy of Sciences]

[Abstract] A study is made of the influence of continuous CO<sub>2</sub> laser radiation in combination with standard heat treatment on the structure, phase composition and properties of wear-resistant high-chromium type IChKh16NMFTL cast iron, used for the manufacture of the vanes of shot-peening apparatus exposed to impact-abrasive wear. The 500 W continuous CO<sub>2</sub> laser achieved a radiation density on the surface of the specimen of 18-160 MW/m<sup>2</sup> with a beam movement rate over the surface of 120-420 mm/min. The studies established that hardening of the iron is achieved by liberation from the martensite matrix of

dispersed  $(\text{Cr}, \text{Fe})_7\text{C}_3$  carbides. To prevent formation of cracks on the surface, the parts were preliminarily heated to  $400^\circ\text{C}$  or higher before laser treatment. The microhardness of the matrix with  $(\text{Cr}, \text{Fe})_7\text{C}_3$ ,  $\text{TiC}$ ,  $\text{Ni}_3\text{C}$  and  $\text{Mo}_2\text{C}$  point carbides reached H1090. The thickness of the laser action zone increased to 0.7 mm, which is quite significant for increasing the life of shot-peening apparatus vanes and other parts operating under shot-abrasive wear conditions. References 9: all Russian.

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#### STRUCTURE AND PROPERTIES OF THERMALLY STABLE DIE STEELS 4Kh3VMS and 3Kh3VMF

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 11, Nov 85, pp 38-41

[Article by S. I. Tishayev, R. A. Zykova, Yu. M. Politayev, S. P. Belyy and L. K. Orzhitskaya, Ukrainian Scientific Research Institute of Special Steels]

[Abstract] Specifics of grain growth of austenite and of the change in phase composition upon heating, as well as the properties of new die steels for hot deformation 4Kh3VMFS and 3Kh3VMF were studied in order to determine optimum hardening temperatures. Type 4Kh3VMFS steel has high thermal stability and is recommended for heavily-loaded die tools operating at impression surface temperatures of up to  $750-800^\circ\text{C}$ . Type 3Kh3VMF steel has superior toughness and resistance to thermal erosion and is intended for the manufacture of hot deformation tools subjected to intensive cooling during operation and casting press molds for pressure casting of alloys based on copper. Type 4Kh3VMFS steel contains 0.42% C, 0.84% Si, 0.37% Mn, 3% Cr, 1.7% W, 1.5% V and 1.6% Mo; 3Kh3VMF contains 0.34% C, 0.46% Si, 0.37% Mn, 2.86% Cr, 1.6% W, 0.9% V, 1.5% Mo and 0.05% N. Austenite grain growth during heating may result from dissolution of carbides, migration of boundaries or boundary 'spreading', which determines the optimal hardening temperature of the steels as  $1120-1140^\circ\text{C}$  for 4Kh3VMFS and  $1060-1080^\circ\text{C}$  for 3Kh3VMF.

References 4: all Russian.

6508/9835  
CSO: 1842/86

## INFLUENCE OF NITROGEN AND VANADIUM ON PROPERTIES OF HEAT RESISTANT TYPE 30KhL STEEL

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 11, Nov 85 pp 44-47

[Article by Ye. G. Aftandilyants, Kh. A. Timashov, Yu. Z. Babaskin and S. A. Turayev, Casting Problems Institute, Ukrainian Academy of Sciences; All-Union Scientific Research Institute of Machine Building Technology]

[Abstract] A study was made of the properties of type 30KhL steel alloyed with molybdenum, nitrogen and vanadium in the ladle in the process of fractional pouring of the metal. The effectiveness of the influence of nitrogen and vanadium on the properties of the steel depends greatly on the degree of dissolution of vanadium nitrides upon austenitization and their subsequent segregation in dispersed form during normalizing or tempering. The optimal austenitization temperature for steel 30KhAFL was found to be 920-970°C, with good mechanical properties attained after hardening from 920-960°C and tempering at 640-660°C. Mechanical properties improved with increasing content of nitrogen and vanadium up to 0.016% and 0.11%, respectively. The steel can be used to replace molybdenum-containing type 30KhML steel in gas and oil wells. References 2: both Russian.

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## STRUCTURE AND PROPERTIES OF DEFORMED 15Kh1M1F STEEL AFTER LONG-TERM AGING

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 11, Nov 85 pp 47-49

[Article by M. B. Balakhovskaya, N. A. Khusainova, Ye. I. Kaminskaya and N. V. Bugay, Urals Affiliate, All-Union Heat Engineering Scientific Research Institute; Donbassenergo PEO]

[Abstract] Type 15Kh1M1F steel is used for the manufacture of steam pipes for high-capacity power units and operates at 540-570°C, meaning that it is subjected to long-term aging at this temperature over hundreds of thousands of hours. Bends, the areas of the pipes subjected to cold deformation during manufacture, are particularly stressed. Hot rolled pipe made of 15Kh1M1F steel was normalized and annealed with subsequent high tempering to produce bainite, ferrite-bainite and ferrite-carbide structures, then stretched by 10-13% to imitate bending and aged at 600°C for 2200 and 4000 hours and at 620°C for 4000 and 7000 hours. These aging modes are equivalent to holding for 100,000



and 200,000 hours at 540 and 570°C. Short-term mechanical properties were determined immediately after deformation, and also after tempering. Microstructural analysis indicated that cold plastic deformation results in segregation of the carbide phase in the steel with bainite structure. The structural changes occurring during aging reduced the strength and increased the ductility and toughness of the steel. The rate of decrease in long-term strength can be used to characterize the stability of the structure. Yield point is decreased by 25-40%, while relative elongation and impact toughness increased by 28-35 and 38-56%. The deformed and tempered steel with bainite structure has greater long-term strength than ferrite-carbide structure steel. No significant changes in the structure of bainite colonies were observed after long-term aging.

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CSO: 1842/86

NONFERROUS METALS AND ALLOYS; BRAZES AND SOLDERS

ZINC PLANT FULFILLS PLAN

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 21 Nov 85 p 1

[Article by L. Leont'yev, staff correspondent, in Ordzhonikidze: "On Resources Saved"]

[Text] The leader of industry in Northern Osetia, the Elektrotsink Plant, has fulfilled the 11th Five-Year Plan in terms of all indices. The electrolytic shop's collective made a major contribution to this success. Of the 10 million kilowatt-hours of electricity saved at the plant, half are attributable to the shop's workers.

The savings were achieved through introduction of cost-accounting.

As a whole, Elektrotsink, an initiator of the republic-wide competition to use resources economically, is successfully fulfilling its high obligations.

12809/9835

CSO: 1842/82

## RADIOISOTOPE UNIT DETERMINES ORE CONTENT

Moscow IZVESTIYA in Russian 22 Nov 85 p 4

[Article by V. Shchepotkin, staff correspondent, East Kazakhstan Oblast: "Treasures from Barren Rock"; passages enclosed in slantlines printed in boldface]

[Text] /Of the 29 USSR State Prizes given in 1985 in the field of technology, two were awarded for development of outstanding nonferrous metallurgy processes. In both developments, the general "application site" was East Kazakhstan Oblast. It is precisely here, at the Ust-Kamenogorsk Lead-Zinc Combine and the Zyryanovsk Lead Combine that high-efficiency processes based on efficient use of polymetal ores, unique in domestic and world practice, have been tested and then implemented over several years./

East Kazakhstan's ores contain more than 40 elements of the Mendeleev table. However, until recently, industry took only individual elements from all this wealth--primarily lead, zinc, copper, gold, and silver. The rest simply could not be extracted: Technology did not permit it. Wastes and, along with them, the so-called rare metals--the ones without which it is impossible to create modern equipment prototypes and materials with predetermined properties--went to the dumps.

Specialists of the Ust-Kamenogorsk Lead-Zinc Combine, in cooperation with scientists of several scientific research institutes, undertook to unravel this knot.

The task was difficult and solved nowhere in the world. The metals are not called rare without reason. A ton of ore contains them in grams. And not one element, but several: tellurium, indium, thallium, cadmium.

Over years of searching, the scientists and specialists of the Combine tried a multitude of procedures and processes until finally they had created the most advanced production facility to date. This facility made it possible to obtain these rare metals along with basic metals. The extent to which it has enriched Soviet and foreign practice is indicated by the fact that the works of this creative collective are protected by 52 USSR author's certificates and 8 patents in capitalist countries.

The start-up of the new process at the Ust-Kamenogorsk Lead-Zinc Combine allowed raw ore to be used more comprehensively. The Combine has now "assimilated" 18 chemical elements in all, which makes it possible to produce 24 types of commodity output.

The second effort of the group of scientists and production specialists was directed at better use of polymetal raw material. They have created at the two combines, including the Zyryanovsk Lead Combine, radioisotope units for automatic determination of the amount of nonferrous metals in an ore even before it is sent to the beneficiation plant and then to the metallurgical facility.

To determine the quality of the extracted mass at the very beginning of the technological chain so that efforts and funds are not wasted on unnecessary transportation and on costly processing of worthless raw material in beneficiation plant shops, and at the same time by pre-sorting to improve ore quality--this is the task which has long confronted the miners of many countries.

Soviet engineers and scientists have managed to solve it. They have created radioisotope units with no domestic or foreign analogs. The highly accurate units automatically determine the amount of useful components in the polymetal ore which is delivered by buggies, dump trucks, railcars, and belt transporters. Devices installed underground at the Zyryanovsk Combine, together with a computer installed on the surface, as well as automatic measuring devices, communications systems, and industrial television, control the process essentially on a current basis.

Automatic radioisotope ore-sorting systems are ecologically harmless, mobile, and quite inexpensive to operate. Their cost is low: 25,000 to 30,000 rubles. However, their use over the current five-year plan has saved more than 3.5 million rubles. And introduction of the innovation into the entire polymetal sub-sector of the USSR Ministry for Nonferrous Metallurgy promises savings of at least 60 million rubles.

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CSO: 1842/82

UDC 669.343

EFFECT OF SMALL SILICON CONCENTRATIONS ON ACTIVITY OF OXYGEN IN LIQUID COPPER

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNAYA METALLURGIYA  
in Russian No 4, Jul-Aug 85 (manuscript received 6 Jun 84) pp 29-33

[Article by I. M. Koval'skiy, I. F. Khudyakov and Ye. I. Yeliseyev, Department  
of Heavy Nonferrous Metals Metallurgy, Ural Polytechnic Institute]

[Abstract] The effect of silicon on the activity of oxygen in liquid copper was studied by the emf method. A  $W/Ni+NiO//ZrO_2+Y_2O_3//[O]_{Cu}/W$  cell was used as a measuring device. Its emf was measured by the compensation method with a BVV-1 high-resistance voltmeter and a P-5848 potentiostat, a KSP-4 potentiometer being used for recording. The temperature of the isothermal zone in a Tamman furnace was held constant within  $\pm 0.5^\circ C$  by means of a VRT-3 high-precision temperature regulator. Cathode copper was immersed in an alundum crucible for melting in a controllable atmosphere of pure argon, whereupon  $CuO$  was added till equilibrium had been reached as indicated by steadiness of the emf within 2 mV over a 30 min period. Then approximately 0.01 g of silicon was added to the melt, whereupon changes in the oxygen activity were continuously recorded. The results have been evaluated on the basis of the Nernst equation, with inclusion of the temperature-dependent partial oxygen pressure in the Ni-NiO system, the activity constant for oxygen in the binary melt, and the silicon-oxygen interaction constant and also with consideration of Henry's law and deviations from it. The equation of silicon oxidation kinetics is found to be of the first order, with the logarithm of activity a linear function of time. The relative error of activity measurement was 6%, according to an evaluation of the corresponding exact derivative. The presence of nickel in the melt decreases the rate of silicon oxidation, probably because of a Ni-Se complex formation. References 3: all Russian.

2415/9835

CSO: 1842/88



## LEAD PHASES IN CONTENT OF COPPER-ELECTROLYTE SLURRY

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNAYA METALLURGIYA in Russian No 4, Jul-Aug 85 (manuscript received 6 Jun 84) pp 33-37

[Article by L. D. Sheveleva, I. A. Kakovskiy, S. A. Vzorodov, L. N. Kovalenko and F. G. Khusainov, Ural Scientific Research and Planning Institute of the Copper Industry; Ural Polytechnic Institute]

[Abstract] For a definitive determination of the lead salts contained in copper-electrolyte slurry, a study of such a slurry from the Uralelektromed' combine was made by the method of selective dissolution. Specimens of decoppered slurry weighing 1 g were dissolved in ethylene diamine and, after desiccation, leached in 0.1 dm<sup>3</sup> of solution with 200 d/dm<sup>3</sup> ethylene diamine, whereupon the filtrate was analyzed for PbSO<sub>4</sub> by the atomic absorption method. At the same time solutions in 25% NaCl were analyzed for PbSO<sub>4</sub> and found to contain 1-2% more of it. Periodic sampling over the 1980-83 period have revealed that the PbSO<sub>4</sub> content in slurry varies and decreases with decreasing total lead content. Another phase analysis, of slurry from the Narilsk Mining and Metallurgical combine, has yielded 17.52% Pb (13.08% Cu, 6.0% Ni, 6.91% Sb) with 60-70 vol.% PbS.Ag<sub>2</sub>S.Sb<sub>2</sub>S<sub>3</sub> as the dominant lead-bearing ingredient and only a fraction of 1% PbSO<sub>4</sub> but approximately 10% PbSiO<sub>3</sub>+CuSiO<sub>3</sub>. Accordingly, composite extraction of precious metals by the hydrometallurgical method requires sulfatization or any other treatment which will facilitate breakup of complex lead compounds into simple lead salts and their dissolution in anodic slurry. References 9: 4 Russian, 1 Bulgarian, 4 Western (1 in Russian translation).

2415/9835

CSO: 1842/88

UDC 541.48-143:546.131

## PHYSICO-CHEMICAL PROPERTIES OF MOLTEN LiCl-KCl MIXTURES WITH YTTRIUM AND LANTHANUM CHLORIDES

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNAYA METALLURGIYA in Russian No 4, Jul-Aug 85 (manuscript received 18 Jan 84) pp 53-58

[Article by A. V. Kovalevskiy and V. I. Shishalov, Department of General Chemistry, Kirov Polytechnic Institute]

[Abstract] For the purpose of optimizing the extraction of rare-earth metals by electrolysis of their molten salts, a study was made of their chlorides mixed with the 60 mol.% LiCl+40 mol.% KCl eutectic. Chemically pure KCl and LiCl were melted and then deaerated, after having been purged of residues by a stream of HCl. To the melt were added separately YCl<sub>3</sub> and LaCl<sub>3</sub> anhydrides which had been grown in crystallizers by slow heating with excess NH<sub>4</sub>Cl under

vacuum. Three properties of these mixtures were measured over the entire range of  $\text{YCl}_3$  or  $\text{LaCl}_3$  concentration, namely density (molar volume)  $\rho$ , electrical conductivity  $\sigma$ , and surface tension coefficient  $\tau$ . The temperature dependence of all three properties was found to be describable by a first-order equation after the data have been processed by the least squares method. The 1050 K isotherm of the molar volume reveals a deviation from additivity, this deviation being positive in the  $\text{LiCl}+\text{KCl}+\text{LaCl}_3$  system and negative in the  $\text{LiCl}+\text{KCl}+\text{YCl}_3$  system over the entire 0-100 mol.% range of  $\text{LaCl}_3$  and  $\text{YCl}_3$  concentration respectively. This is attributable to ability of yttrium ions to form higher-density complexes in the system. The 1050 K isotherm of molar electrical conductivity  $\sigma/\rho$  reveals a monotonic sigmoidal decrease of the latter with increasing  $\text{LaCl}_3$  or  $\text{YCl}_3$  concentration, explainable by formation of low-mobility complex ions at low concentrations. The surface tension coefficient peaks to a maximum in the low-concentration range and dips to a minimum in the high-concentration range, attributable to the displacement first of lithium ions by yttrium or lanthanum ions and then of yttrium or lanthanum ions by lithium ions with yttrium or lanthanum forming other complexes. On the basis of these data calculations were made of the 1050 K isotherms of excess free energy, excess enthalpy, excess entropy, and the Gibbs absorption. The trends of their concentration dependence, different for  $\text{YCl}_3$  and  $\text{LaCl}_3$  but all nonmonotonic (except the monotonically increasing excess free energy of the  $\text{LiCl}-\text{KCl}-\text{LaCl}_3$  system) are also explainable by formation of various complex ions in addition to  $(\text{Y},\text{La})\text{Cl}_6^{3-}$ , namely  $(\text{Y},\text{La})\text{Cl}_5^{2-}$ ,  $(\text{Y},\text{La})_2\text{Cl}_7^-$  and  $(\text{Y},\text{La})_3\text{Cl}_{10}^-$ . References 7: 3 Russian, 4 Western.

2415/9835

CSO: 1842/88

UDC 669.017

# DEPENDENCE OF STRUCTURE AND SUPERPLASTICITY INDICATORS OF Al-Mg-Mn ALLOYS ON COMPOSITION AND HOMOGENIZATION OF INGOTS

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNAYA METALLURGIYA in Russian No 4, Jul-Aug 85 (manuscript received 10 Oct 83) pp 75-79

[Article by V. K. Portnoy, N. S. Zhuravleva, O. A. Korabel'nikov and A. O. Nikiforov, Department of Nonferrous, Rare and Radioactive Metals Science, Moscow Steel and Alloys Institute

[Abstract] A study of Al-Mg-Mn alloys was made, for the purpose of determining the dependence of their structure and superplasticity indicators after recrystallization on the Mn content and on the homogenizing heat treatment of their ingots. Three alloys were cast and tested in addition to the basic AMg6 alloy (A99 aluminum + 6.3% Mg9 magnesium + 0.06% titanium), namely with respectively 0.4%, 0.8% and 1.2% Mn added. The ingots were homogenized by annealing at 370-470°C for liquidation of semimolten dendrites and dissolution of precipitated excess  $\text{Al}_3\text{Mg}_2$  phase, with the treatment time

lengthened stepwise from 10 h to 30 h so as to allow more uniform distribution of the  $Al_6Mn$  phase precipitated in the process. Homogenization was followed by three stages of compression treatment--hot rolling at the homogenization temperature to 75% reduction (to 5 mm thickness)--cold rolling to 40% reduction (to 3 mm thickness)--warm rolling to 67% reduction (1 mm final thickness), and subsequent recrystallization annealing in a  $KNO_3$  bath at 500°C. Mechanical tests were performed with an R-05 tensile loading machine at different strain rates at 420°C. The superplasticity indicators were determined from stress-strain curves and strain-teim curves and also from stress relaxation tests. Correlation with the grain size was established on the basis of microstructural analysis. The results reveal that an increase of the Mn content causes an increase of the percentage superplastic deformation within the  $10^{-3}$ - $10^{-1}$  s $^{-1}$  range of strain rate, and that this increase is maximum in an alloy structure with grains in the 21  $\mu m$  fraction. On the basis of this study, adding an intermediate amount of manganese close to the 0.8% standard upper limit is recommended for making the AMg6 superplastic. References 7: 6 Russian, 1 Western.

2415/9835  
CSO: 1842/88

UDC 669.017

#### DEPENDENCE OF RECRYSTALLIZATION OF Al-Sc ALLOYS ON DISPERSIVITY OF $ScAl_3$ -PHASE PRECIPITATE

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNAYA METALLURGIYA in Russian No 4, Jul-Aug 85 (manuscript received 9 Apr 84) pp 80-84

[Article by M. Ye. Drits, L. S. Toropova and Yu. G. Bykov, Metallurgy Institute imeni A. A. Baykov]

[Abstract] Since secondary precipitation of the  $ScAl_3$  phase plays the major role in hardening of Al-Sc alloys, quantitative relations describing the dependence of recrystallization temperatures  $T_r^b$  (beginning) and  $T_r^e$  (end) on the distribution of this phase will indicate how the hardening $_r$  process can be optimized. A study was, therefore, made on two alloys containing 0.21% Sc and 0.40% Sc respectively. Strip specimens, after being variously precipitation hardened (at 250°C for 25 h, at 350°C for 1 h, at 400°C for 1 h, at 400°C for 50 h, at 450°C for 12 h) and with accordingly different distributions of the  $ScAl_3$  phase, were cold rolled to 60% thickness reduction and then annealed at various temperatures 25 K apart for 1 h at each. The three parameters of  $ScAl_3$  distribution, namely volume fraction  $f$ , particle radius  $R$ , and interparticle distance  $L$ , were determined under a JEM-200A electron microscope. The data reveal an almost identical behavior of both alloys in terms of  $T_r^b$  and  $T_r^e$  temperatures as functions of  $1/L$  and  $f/R$ . The temperature at which recrystallization begins remains within the 200-250°C range when  $1/L$  and  $f/R$  are below critical, then steeply increases to within

the 350-400°C range and remains there when  $l/L$  and  $f/R$  are above critical, the critical value of  $l/L$  corresponding to  $L = 300$  nm and the critical value of  $f/R$  corresponding to  $R = 14$  nm. The temperature at which recrystallization ends lies within the 500-550°C range throughout. References 7: 6 Russian, 1 Western (in Russian translation).

2415/9835

CSO: 1842/88

UDC 669.017

#### HIGH-TEMPERATURE CREEP IN MULTILAYER TITANIUM-ALLOY COMPOSITES WITH CONTROLLED MICROSTRUCTURE

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNAYA METALLURGIYA in Russian No 4, Jul-Aug 85 (manuscript received 11 Jun 84) pp 84-88

[Article by V. N. Rodionov and V. V. Peshkov]

[Abstract] A study of creep in  $\alpha$ -phase and  $(\alpha + \beta)$ -phase titanium alloys was made, high-temperature creep in these alloys during diffusion welding being highly sensitive to their initial microstructure. Since the purpose of this study was optimization of the welding process, to ensure high-quality high-precision joints of these alloys, multilayer specimens were produced by diffusion welding for test and evaluation. Stacks of the OT4 alloy were welded at 950°C and stacks of the VT20 alloy were welded at 975°C, all stacks under a pressure of 5 MPa. Each 40 mm high stack consisted of 0.3-1.0 mm thick sheets  $15 \times 15$  mm<sup>2</sup> large, being a controlled mix of sheets with fine-grain structure and sheets with coarse-grain structure. The microstructure of stacks was thus controlled by varying the volume fraction of the coarse-grain component over the 0-100% range. From these blank stacks cylindrical specimens 11.3 mm in diameter and 30 mm high were cut for high-temperature creep test at 850-950°C (OT4 alloy) and 900-975°C (VT20 alloy) under a pressure varied over the 1-20 MPa range, with the load applied either transversely (shear) or normally (compression). A quantitative evaluation of the test data, taking into account the creep activation energy and the rule of mixtures, has yielded semiempirical relations for the creep rate as a function of pressure, absolute temperature, and volume fraction of the coarse-grain component. In the case of a normal load the creep rate depends also on the thickness of the coarse-grain layers. The results indicate that the high-temperature creep rate in such composites of these titanium alloys can be readily regulated over the  $10^{-4}$ - $10^{-8}$  s<sup>-1</sup> range. References 8: 7 Russian, 1 Western (in Russian translation).

2415/9835

CSO: 1842/88



## STABILITY OF SILICON COATINGS ON OT4 TITANIUM ALLOY UNDER CYCLIC HEAT LOAD

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNAYA METALLURGIYA  
in Russian No 4, Jul-Aug 85 (manuscript received 12 Nov 84) pp 88-90

[Article by I. N. Burnyshev, L. A. Vasil'yev and V. G. Mikonenko, Department  
of Metallography, Belorussian Polytechnic Institute]

[Abstract] The stability of various silicon coatings under cyclic heat load was studied, such coatings on titanium alloys forming under normal conditions a heat-resistant  $\text{TiSi}_2$  layer. They were deposited on 1.5 mm thick and  $30 \times 10 \text{ mm}^2$  large plates of the OT4 titanium alloy with thermochemical treatment: 97% Si + 3%  $\text{AlF}_3$  coatings at  $1050^\circ\text{C}$  for 6 h, 73% Si + 20% Cu + 5% Sn + 2%  $\text{AlF}_3$  coatings at  $850^\circ\text{C}$  for 4 h, 73% Si + 20% Cu + 5% Zn + 2%  $\text{AlF}_3$  coatings at  $800^\circ\text{C}$  for 4 h, or at  $850^\circ\text{C}$  for 1 h, or at  $850^\circ\text{C}$  for 2 h, or at  $950^\circ\text{C}$  for 2 h. The specimens were heated to  $1000^\circ\text{C}$ , held at that temperature, and cooled to  $100^\circ\text{C}$  in cycles of 100 s duration. This was done in air at atmospheric pressure, in oxygen at atmospheric pressure, and in oxygen rarefied to a pressure of 0.05 atm. All coatings withstood 1800 cycles in air, with defects in the form of "folding" cracks filled with oxides developing in the process. Only the Si-Cu-Zn coatings withstood 1800 cycles in oxygen at atmospheric pressure and only some of them (those heat treated at  $950^\circ\text{C}$  for 2 h) withstood 1800 cycles in rarefied oxygen. Evidently, silicon is more volatile than titanium in rarefied oxygen so that the heat-resistant  $\text{TiSi}_2$  phase loses silicon and converts into  $\text{TiSi}$  and  $\text{Ti}_5\text{Si}_2$  phases without formation of a protective  $\text{SiO}_2$  film which would fill the cracks so as to prevent oxygen from penetrating to the base metal and embrittle it. The better characteristics of Si-Cu-Zn coatings are attributable to their higher plasticity. They were also tested under simultaneous temperature cycling ( $10 \pm 1000^\circ\text{C}$ ) and pressure cycling ( $0.01 \pm 1 \text{ atm}$ ) in an oxygen atmosphere in 100 cycles of 600 s duration each. References 2: both Russian.

2415/9835

CSO: 1842/88



## BEHAVIOR OF RARE-EARTH ELEMENTS DURING CHLORINATION OF ZIRCONIUM CONCENTRATE

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNAYA  
METALLURGIYA in Russian No 4, Jul-Aug 85 (manuscript received 5 Jul 84)  
pp 111-112

[Article by B. G. Korshunov, Ye. Yu. Voytsekhovskaya, I. I. Yelfimov and  
N. V. Pirkovskaya, Moscow Steel and Alloys Institute; State Scientific  
Research and Planning Institute of the Rare-Metals Industry]

[Abstract] During chlorination of zirconium concentrate in the presence of a carbonaceous reducer, chlorides of rare-earth elements were found to form and concentrate in the carbonaceous residue. In an experiment performed for a quantitative analysis of this process, high-temperature coal tar containing 58-60% C was used as reducing agent and a lye solution of sulfite pulp (density 1.24 g/cm<sup>3</sup>) was used as binder for caking. Cakes were coked at 900°C for 6 h. Chlorination was done in a vertical tubular quartz vessel at 1000°C for 6 h, with chlorine supplied at a rate of 60 dm<sup>3</sup>/h for treatment of specimens weighing 700 g. The residue was split into four size fractions: -0.074 mm (25.6%); -0.14 + 0.074 mm (11.9%); -0.28 + 0.14 mm (19.6%); -1 + 0.28 mm (42.9%). Quantitative determination of ZrO<sub>2</sub>, SiO<sub>2</sub>, TiO<sub>2</sub>, Al<sub>2</sub>O<sub>3</sub>, Fe<sub>2</sub>O<sub>3</sub>, ΣCaO + MgO and P<sub>2</sub>O<sub>5</sub> was done by standard chemical methods, the remainder being oxides of rare-earth metals. X-ray analysis was performed on a DRON-2 diffractometer with filtered copper radiation. The total content of ΣR<sub>2</sub>O<sub>3</sub> (mainly oxides of the "heavier" rare-earth elements) in the residue was 2.1 wt.%, most of it (0.28-0.35%) in the finest size fraction. References 5: 3 Russian, 2 Western (1 in Russian translation).

2415/9835  
CSO: 1842/88

UDC 541.123+669.891

SOLUBILITY OF HEAVY NONFERROUS METALS IN NaCl-KCl-CaCl<sub>2</sub> MELT

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNAYA  
METALLURGIYA in Russian No 4, Jul-Aug 85 (manuscript received 16 Dec 83)  
pp 120-121

[Article by B. A. Khorishko, A. V. Volkovich and I. F. Nichkov, Department  
of Electrochemistry, Moscow Chemical Technology Institute, Novomoskovsk  
Branch]

[Abstract] The solubility of tin, lead, bismuth, cadmium and their alloys with sodium in a NaCl-KCl-CaCl<sub>2</sub> melt was measured for comparative evaluation, within the framework of a feasibility study concerning extraction of heavy nonferrous metals from the saline phase through exchange reaction between their

alloys with sodium and a chloride melt. The experiment was performed with KD-0 cadmium, VCh-000 very-high-purity tin and bismuth, chemically pure lead, and analytically pure sodium. The sodium alloys, containing 32 atom.% Na, were produced by direct smelting together of precise amounts in an inert gas atmosphere. The chloride melt contained an equimolar NaCl-KCl mixture and 3.1 mol.%  $\text{CaCl}_2$ . The solubility tests were performed at 973 K in an argon atmosphere and the concentration of heavy metal in the melt was measured with an ISP-22 spectrometer. The results indicate that the solubility of Sn, Pb, Bi, Cd in such a melt is  $7.4 \cdot 10^{-5}$ ,  $2.9 \cdot 10^{-4}$ ,  $6.8 \cdot 10^{-3}$ ,  $6.1 \cdot 10^{-2}$  mol.% respectively, much higher than in a pure NaCl-KCl melt, with intermetallic compounds  $\text{CaSn}$ ,  $\text{Ca}_2\text{Pb}$ ,  $\text{Ca}_3\text{Bi}$ ,  $\text{CaCd}_2$  forming correspondingly. The ionicity of these intermetallic compounds, with the enthalpy of their formation process known, can be described by the relation  $i_{\text{Me-Ca}} = 1 - e^{-\alpha(E_{\text{Me}} - E_{\text{Ca}})^2}$

(E- electronegativity of metal, Me = Sn, Pb, Bi, Cd,  $\alpha = 0.18$ ). References 14: 7 Russian, 7 Western (5 in Russian translation).

2415/9835

CSO: 1842/88

UDC: 669.783:621.791.85

# PROCESSES OF RADIATION DEFECT FORMATION IN GERMANIUM ALLOYED WITH COPPER UPON FAST ELECTRON BOMBARDMENT

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 5, Sep-Oct 85  
(manuscript received 4 Jan 84) pp 6-12

[Article by V. F. Degtyarev and Ye. V. Skudnova, Moscow]

[Abstract] Results are presented from an experimental and theoretical study of the influence of electron bombardment on the electrophysical properties of germanium alloyed with copper. The effect of electrons with energies of 2.2 and 22 MeV on electrophysical properties of germanium alloyed with copper and antimony was studied as were the kinetics of defect formation.

References 7: 6 Russian, 1 Western.

6508/9835

CSO: 1842/65

## FORMATION OF PORES IN ALUMINUM BY LASER EFFECTS

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 5, Sep-Oct 85  
(manuscript received 28 Jan 85) pp 25-27

[Article by L. I. Ivanov, Ye. Ye. Kazilin, Yu. M. Platov, S. V. Simkaov and V. A. Yanushkevich, Moscow]

[Abstract] The purpose of this work was to determine structural changes in metal after treatment by a method significantly increasing the role of impact pressure in comparison to purely thermal effects. Pure aluminum specimens 3 mm in diameter and 150  $\mu$ m thick were placed in a cuvette with water and struck by single laser pulses  $5 \cdot 10^{-8}$  s in length, having an energy of about 15 J. The peak radiation intensity on the surface of the specimen was  $8 \cdot 10^8$  W $\cdot$ cm $^{-2}$ . Electron microscope studies were then performed. In specimens irradiated at 20°C unusual defect forms were observed, similar to tracks, about 2  $\mu$ m in length and with a transverse cross section of about 50-1000 Å. The crystallographic orientation of the defects coincided with the <100> lattice of the matrix. Laser radiation was demonstrated to imitate radiation damage, particularly pore formation. References 6: 4 Russian, 2 Western.

6508/9835

CSO: 1842/65

UDC: 669.872.5'79:536.421.4

## INFLUENCE OF MAGNETIC FIELD ON IMPURITY HETEROGENEITIES IN INDIUM ANTIMONIDE SINGLE CRYSTALS

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 5, Sep-Oct 85  
(manuscript received 14 Jan 85) pp 50-56

[Article by V. S. Zemskov, M. R. Raukhman and D. P. Mgaloblishvili, Moscow]

[Abstract] A study is presented of the effect of a magnetic field on impurity heterogeneity in indium antimonide crystals alloyed with tellurium and grown by the Chokhral'skiy method. Two series of experiments were performed, the initial stage in both of which was the same: melting, holding for 30-40 minutes, seeding and production of the crystal with rotation of the seed without a magnetic field. In the first series, the seed continued to rotate after the diameter was established; a magnetic field was then switched on and gradually increased to a fixed value. In the second series, after the diameter was established, the growth rate was dropped to zero and the magnetic field switched on. Further growth occurred without rotation of the seed. Magnetic induction of 0.4-0.45 T with no forced mixing of the melt yielded crystals with complete elimination of layer heterogeneity. In non-layered crystals grown in the magnetic field without rotation, local impurity zones can form with higher concentrations of impurities. It is thought that

improvement in thermal symmetry over the transverse cross-section of the crucible will yield single crystals with no impurity heterogeneities without rotation. References 23: 14 Russian, 9 Western.

6508/9835

CSO: 1842/65

UDC 669.713.7

#### THERMALLY INSULATING CONCRETES WITH SHUNGITE OR SHUNGISITE FILLER FOR LINING ALUMINUM ELECTROLYZERS

Moscow TSVETNYYE METALLY in Russian No 11, Nov 85 pp 37-40

[Article by V. V. Slavin, N. V. Skobeleva, B. A. Kamenev and L. A. Bezukladnikova]

[Abstract] Heat-resistant concretes are considered for lining aluminum electrolyzers, in preference to firebrick or diatomite, on account of their high strength and long life as large monolithic structures. Shungite is considered for use as filler material to ensure adequate thermal insulation as well as chemical stability and corrosion resistance. Of the five known shungite varieties, grade V with less than 10% carbon content occurring in shale deposits (natural density 2.74-2.84 g/cm<sup>3</sup>, hardness 4-5 on the Mohs scale, compressive strength 110-180 MPa) swells most readily and therefore is most suitable for this purpose. A porous filler, shungisite, is produced by letting the iron oxides in the mineral component of shale react with the carbon in an oxidation-reduction process. Portland cement or Portland blast furnace slag can be used as binder material cement. Two formulations of concrete mix developed with these ingredients have been used for lining an electrolyzer in the Leningrad experimental aluminum production plant and found to remain adequate after 40 days of electrolyzer operation at a temperature of 955-965°C with a current density of 1.0 A/cm<sup>2</sup>. References 2: both Russian.

2415/9835

CSO: 1842/83

UDC 669.35

#### USE OF ANTIFRICTION Si-Mn BRASSES INSTEAD OF BRONZES

Moscow TSVETNYYE METALLY in Russian No 11, Nov 85 pp 64-66

[Article by G. B. Gershman, V. V. Kotov, V. A. Tkachenko, B. V. Tyurin and A. I. Leykin]

[Abstract] Substitution of antifrictional brasses for tin bronzes in hydrostatic transmissions for tractors and other farm machinery is considered because

of both economic and technical advantages. A comprehensive study made for GST-90 transmissions has resulted in the selection of LMtsSKA 58-2-2-1-1 and LMtsKNS 58-3-1.5-1.5-1 molded Si-Mn brasses as having the best wear and friction characteristics for the given application. Transmissions with pivot journals, ball and piston bushings made of these brasses were tested in "Don 1200," KSK-100 and KSKU-6 tractors, the results guaranteeing a long life under normal operating conditions. The replacement should yield a cost saving of 1.75 million rubles to the national economy.

References 2: both Russian.

2415/9835

CSO: 1842/83



UDC 621.315.592

CURRENT-VOLTAGE CHARACTERISTICS OF VARISTORS MADE OF DIAMOND CERAMIC  
CONTAINING SiC

Kiev SVERKHTVERDYIE MATERIALY in Russian No 5, Sep-Oct 85  
(manuscript received 26 Jun 84) pp 15-17

[Article by A. V. Bogdanov, N. I. Dzhantimirova, I. N. Zmiyevskiy,  
Yu. N. Potashev and L. A. Plotnikova, Kherson Industrial Institute,  
Kherson]

[Abstract] Mixing high-resistivity diamond ceramic with low-resistivity black SiC ceramic yields a new varistor material with a nonlinear current-voltage characteristic. An experimental study was made to determine the dependence of its electrical resistivity on its SiC content and also the electrophysical characteristics of such varistors. Electrical contact resistance between diamond and SiC grains in the mixture was minimized by addition of 10 wt.% borax as binder and as scourer of the SiO<sub>2</sub> film. After aluminum contact tabs had been deposited on 2 mm thick pellets 12 mm in diameter by the Schoop metallization process, measurements were made in the high-current range typical of varistor operation with direct current as well as with single voltage pulses coming from a 10  $\mu$ F capacitor bank. The results indicate a sharp decrease of the electrical resistance and a subsequent linearization of the current-voltage characteristic as the SiC content exceeds 20-40 wt.%, with scouring of the SiO<sub>2</sub> film by borax beginning at approximately 800°C. This trend is adequately explained by the flow-through theory. The trend of the current pulse amplitude as a function of the voltage pulse amplitude for a varistor with high diamond content (80 wt.% or more) corresponds to an n-type negative differential resistance over the 150-250 V range at room temperature, similar to that of a pure diamond varistor at 400°C. References 6: all Russian.

2415/9835  
CSO: 1842/69

## MICROWAVE CONDUCTIVITY OF DEFECTIVE SILICON LAYER

Moscow POVERKHNOST' in Russian No 11, Nov 85 (manuscript received 11 Jan 84)  
pp 16-20

[Article by N. G. Borzunov, G. N. Danilov, M. V. Detinko and  
Yu. V. Medvedev, Physical-Technical Siberian Institute, Tomsk State  
University]

[Abstract] A method of measuring the electrical conductivity of defective high-resistivity (up to  $2 \cdot 10^5$  ohm.cm) silicon substrates at microwave frequencies is proposed, namely by recording the microwave power loss which free charge carriers in the subsurface layer made defective by mechanical treatment during fabrication contribute to the loss in a resonator. Measurements are made with a resonator cavity coupled to the tested silicon substrate through a hole in the resonator wall, with an inductive post typically 0.67 mm in diameter, and a layer of dielectric material having a small loss tangent inserted underneath the silicon substrate. The validity of this method is based on the hypothesis that, unlike d.c. power, microwave power passing through or absorbed by such a resonator depends solely on the mean-volume conductivity of the substrate. Measurements made on substrates after grinding reveal that the power passing through the resonator first increases linearly with increasing thickness of material removed by grinding, until it reaches a level at which it remains constant as more material is removed. This corresponds to the model of a substrate as consisting of two layers, a thick perfect one underneath a thin defective one, each having a different dielectric permittivity. Excess losses in the resonator are attributable to a high-conductivity space charge regions adjoining the interfaces in the semiconductor crystal lattice. References 8: 7 Russian, 1 Western (in Russian translation).

2415/9835  
CSO: 1842/89

FORMATION OF DISLOCATION STRUCTURE ON SILICON SURFACE UNDER CONTINUOUS SCANNING RADIATION OF CO<sub>2</sub>-LASER

Moscow POVERKHNOST' in Russian No 11, Nov 85  
(manuscript received 29 Jun 84, in final version 19 Nov 84) pp 26-29

[Article by A. V. Demchuk, A. M. Pristrem, N. I. Danilovich and  
V. A. Labunov, Minsk Radio Engineering Institute]

[Abstract] An experimental study of the dislocation structure buildup on the surface of silicon during treatment of the latter with continuous scanning

CO<sub>2</sub>-laser radiation (wavelength  $\lambda = 1.06 \mu\text{m}$ ) was made, the mechanical effect associated with thermoelastic lattice vibrations and crystal strains being of particular interest. Single-crystal silicon KEF-20 wafers having a (100) surface orientation and KBD-0.3 wafers having a (111) surface orientation, with a 0.5  $\mu\text{m}$  thick SiO<sub>2</sub> alayer thermally grown at 1050°C were used as substrates, on which 0.5  $\mu\text{m}$  thick polycrystalline silicon layers doped with phosphorous to a charge carrier concentration  $n = 1 \cdot 10^{19} \text{ cm}^{-3}$  were chemically deposited from the vapor phase. These structures were treated with continuous radiation of  $10^4 \text{ W/cm}^2$  power density from a CO<sub>2</sub>-laser scanning the substrate surface at rates of 2.5-10 cm/s, with the focused spot 0.065 cm in diameter and with the overlap of scan lines varied over the 70-90% range, while the substrate temperature was varied over the 400-600°C range. The results of examination under an optical microscope revealed plastic slip originating within a small site on the Si side of the Si-SiO<sub>2</sub> interface and propagating along the entire slip plane, this process being strongly dependent on the substrate temperature. The predominant plastic relaxation of stresses in slip directions closest to the direction of scan is determined by the asymmetry of both temperature and stress fields. Buildup of the dislocation structure was found to depend also on the degree of overlap of scan lines, more overlap resulting in stronger interaction of glissile dislocations and the regular slip lattice. Lowering the substrate temperature was found to inhibit plastic relaxation of lattice strains and allow the higher stresses within the treatment zone to cause cleavage of the material along close-packed crystallographic planes. Increasing the scan rate was found to cause redistribution of thermoelastic stresses without plastic deformation of the structure. References 9: all Western (2 in Russian translation).

2415/CSO: 1842/89

UDC 535.361

#### EFFECT OF LASER ANNEALING ON RAMAN SCATTERING SPECTRA IN IMPLANTED SILICON LAYERS

Moscow POVERKHNOST' in Russian No 11, Nov 85 (manuscript received 24 Dec 84) pp 30-33

[Article by V. S. Gorelik, R. N. Khashimov, A. R. Begishev and M. M. Sushchinskiy, Physics Institute, USSR Academy of Sciences, Moscow]

[Abstract] Laser annealing of silicon crystals before and after implantation of phosphorus ions ( $4.38 \cdot 10^{14} \text{ cm}^{-2}$  with 75 keV energy) was studied, for an evaluation of its effect on the Raman scattering spectrum in such crystals. Layers of such silicon crystals with [111] orientation were treated with radiation pulses of 0.7-1.0 J/cm<sup>2</sup> energy density and 10-20 ns duration from a YAG-laser (wavelength  $\lambda = 530 \text{ nm}$ ). Some of the specimens were subsequently heat treated at 750-900°C in an inert atmosphere for 30 min, for additional annealing. Raman scattering spectra were excited in the crystals, before and after treatment, by radiation from a 0.5 W Ar-laser (wavelength  $\lambda = 488 \text{ nm}$ )

in the reflection mode. Treatment of pure Si single crystals with YAG-laser pulses of  $0.9 \text{ J/cm}^2$  energy density was found to increase the intensity of the  $520.9 \pm 0.3 \text{ cm}^{-1}$  Raman scattering line by 80%, without shifting its frequency or changing its width. This line had vanished upon implantation of arsenic, indicating complete amorphization of the  $0.05 \text{ m}$  thick subsurface layer. Subsequent laser treatment of such a doped Si single crystal produced a wide Raman scattering band with a major peak at  $520.9 \pm 0.3 \text{ cm}^{-1}$  frequency and a minor peak at  $514.8 \pm 0.3 \text{ cm}^{-1}$  frequency, with the form of the spectrum changing along the path from the periphery to the center of a crystal. The intensity of these lines increased while their half-width and asymmetry decreased with increasing energy density of the laser pulses, indicating a transition of the layer surface from an almost amorphous one after annealing with a weak laser pulse ( $0.7 \text{ J/cm}^2$ ) to an almost crystalline one after annealing by a strong laser pulse ( $1.0 \text{ J/cm}^2$ ). These effects were found to be even stronger in Si single crystals doped with phosphorus. In those, moreover, heat treatment after treatment with laser pulses of  $0.8 \text{ J/cm}^2$  energy density restored the Raman scattering spectrum line to that in pure Si single crystals, without asymmetry, its intensity increasing with higher annealing temperature up to  $850^\circ\text{C}$  and then decreasing slightly with still higher annealing temperature. The results are interpreted in terms of amorphization-recrystallization, dislocation-relaxation, and impurity concentration-diffusion mechanisms. References 6: 1 Russian, 5 Western.

2415/9835

CSO: 1842/89

## PREPARATION

### NEW SHOP BEING BUILT AT LIPETSK COMBINE

Moscow IZVESTIYA in Russian 10 Nov 85 p 1

[Article by V. Komov, staff correspondent, Lipetsk: "A Giant Shop is Being Built"]

[Text] Builders in Lipetsk are constructing a giant dynamo steel shop at the Novolipetsk Metallurgical Combine. They have fulfilled an annual plan of 3.5 million rubles worth of construction and installation work.

This is not the first year that this collective is in the front ranks of the All-Union socialist competition. Dozens of unique enterprises are to its credit. Preparing for the 27th Party Congress, the builders and installation workers of Lipetsk have decided to devote the entire month of December to work for the 12th Five-Year Plan.

12809/9835

CSO: 1842/82



CONTINUOUS CASTER INSTALLED AT FAR EASTERN PLANT

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 23 Nov 85 p 1

[TASS article from Komsomolsk-na-Amur: "Ahead of Schedule"]

[Text] Yesterday, installation of a continuous caster was completed at the Far Eastern Metallurgical Plant, which is now under construction. This made it possible to begin no-load testing of equipment ahead of schedule and to accelerate start-up and adjustment work. The builders intend to hand over the project for operation before the end of the year.

12809/9835

CSO: 1842/82

## NEW PLATE ROLLING MILL BEGINS OPERATION AT IZHORA

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 30 Nov 85 p 1

[Article by V. Ponomarev, staff correspondent, Leningrad: "The Giant at Izhora"]

[Text] Yesterday, the Izhorskiy Zavod Association put into operation the country's largest plate rolling mill, the 5000. The giant mill produced its first output 6 months ahead of schedule. Leningra workers have uifilled this important obligation as a worthy welcome to the 27th CPSU Congress.

The atmosphere in the plate rolling mill shop is tense. Only hours remain until the mill is to start up. Operators have manned the control panels. Machinists, hydraulics specialists, and electricians are working on the assemblies and units of the very complex equipment. Current information on the readiness of the technological components of the start-up complex comes to the 5000 mill construction site headquarters.

A 5-minute meeting of the coordination council has just ended. Number One readiness is announced to all services.

"Today, our mill is taking its final exam," says the chief of the plate rolling shop, V. Yelyakin. "And along with it, the collectives of almost 30 building, installation and tune-up and adjustment organizations participating in the creation of the complex."

Here are some numbers which indicate the scale of the Izhora building project: the first section of the plate rolling mill complex occupied more than 70,000 square meters. In the main building's 400-meter bay, the metal structures and equipment soared to the height of a 10-story building. The foundations extended to a depth of 25 meters. The heart of the mill is a 4-high Quarto stand weighing 5,500 tons. It is 17 meters high. During rolling it withstands a force of 9,000 tons.

The 5000 Mill is intended to produce one-of-a-kind product. For the first time in this country, large rolled product with a width up to 5 meters and a thickness from a few millimeters to half a meter will be produced. The weight of the rolled product made from special steel grades will reach 90 tons. In power machine-building, these plates will replace forged blanks.

This will ensure unprecedented savings in metal in the manufacture of atomic reactors--up to a thousand tons per each "millionaire." In shipbuilding, large plates will help reduce welding work by a factor of 1.5. Thus, extensive use of the 5000 mill's products will yield tremendous savings.

The Izhora power machine-builders, in adopting their own counter-plan, oriented themselves precisely toward this final result. The client became the main supplier of the project. The association's collective has manufactured half of all the equipment for the rolling mill complex.

Efficient organization of labor and the high professionalism of the workers at Izhora were the solution. The association formed a specialized shop for fulfilling the construction project's orders. Many collectives sent their best machinists there. Builders from Kolpino supported the counter-plan of the Izhora people. The plate mill complex became the target of a "working relay race." It united all participants in the construction and aimed at the final result, and the mighty mill grew heroically.

The agreement on creative cooperation states: "Considering the economic and national importance of the plate mill complex with the 5000 mill, the start-up of its first phase is to take place 6 months ahead of schedule." Sample rolled product was produced at the beginning of the current 6-month period. It has confirmed the reliability of the working guarantee. And now, the final hurdle. The command is given, "Start!"

...A steel blank cast by Izhora metallurgists and heated to 1,200° moved along the roller table to the scarfing machine. The next command from the control desk, and the blank is in the Quarto stand. Beneath the powerful pressure of the rollers, spraying fireworks of blinding sparks, the steel block flattens out. One pass, another--and the glistening body is pulled out of the stand. Now it must be heat treated and cooled.

The cooled metal is embossed with "Izhorskiy Zavod" and "Minenergomash." By the end of the year, the 5000 mill will produce 1,500 tons of new rolled product.

"Now the main task is to bring the 5000 up to designed capacity, 100,000 tons of rolled product per year," says the shops's deputy chief, V. Kuzmin. The scheduled deadline is 1 October of next year. The association's collective, preparing a worthy welcome for the 27th CPSU Congress, has decided to move this deadline up significantly. A new date has been recorded in the socialist obligations--the 116th anniversary of V. I. Lenin's birth.

In the 12th Five-Year Plan, construction of the second, and then the third, phase of the giant plate mill will start at Izhora.

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CSO: 1842/82

## NEW ROLLING MILL BEING INSTALLED AT LIPETSK COMBINE

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 30 Nov 85 p 1

[Article by N. Klimov, staff correspondent, Lipetsk: "Tightening up the Schedule"]

[Text] Leaders in the pre-Congress competition, the fitters and machinery installers of the brigade from the Metallurgprokatmontazh Trust headed by Hero of Socialist Labor B. Grigoryev, have installed the first multi-ton units of production equipment for the four-high rolling mill in the building housing the huge dynamo steel shop. This shop is being built at the Novolipetsk Metallurgical Combine. It is not a simple matter: assembling the mill's 3,000-piece frame, precisely fitting each of the hundreds of assemblies so that, at the operator's command from the panel, the lead rolling unit functions without problems. This important matter was not entrusted to B. Grigoryev's team by accident: the fitters are credited with completing the erection of many unique rolling mills for the Lipetsk Magnitka.

The fitters of the enlarged brigade together with the administration's engineers, reckoned their capabilities, precisely analyzed their strengths, and pledged to install the rolling mill ahead of time, by the day the 27th CPSU Congress opens, so that tune-up and adjustment of individual units would begin not in April, but 2 months earlier. The team had to review and tighten up the schedule. To accelerate the work, the machinery installers are using hydraulic jacks instead of rigging wedges. These make installation operations faster, more accurate, and more reliable. Other innovations are being used to speed up the work, especially a high-precision level which measures hundredths of a millimeter using a laser beam in installing units.

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CSO: 1842/82

EFFECT OF HEAT TREATMENT ON PHASE COMPOSITION OF SPENT ALUMINO-PALLADIUM CATALYSTS AND ON LIXIVIATION OF PALLADIUM

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNAYA METALLURGIYA in Russian No 4, Jul-Aug 85 (manuscript received 3 Apr 84) pp 63-67

[Article by I. Yu. Lovchinovskiy, S. F. Belov and M. S. Igumnov, Department of the Chemistry and Technology of Rare and Scattered Elements, Moscow Fine Chemical Technology Institute]

[Abstract] A study of spent palladium catalysts on alumina substrate was made, the purpose being to determine their suitability for reconditioning after they had been used for organic or inorganic synthesis. Differences in the palladium and impurity content as well as in the alumina structure depending on which kind of synthesis a catalyst had been used for, and changes which had occurred during subsequent heat treatment by roasting, were detected, measured, and analyzed. After complete dissolution of the spent catalyst for quantitative analysis, determination of the palladium content was made by the spectrophotocalorimetric method and determination of Cr, Fe, Ni, S. C was made by chemical methods. The phase composition was determined with a DRON-1 x-ray diffractometer using a  $\text{CuK}_\alpha$  radiation source and a nickel filter. Thermogravimetric analysis was performed with a Paulik derivatograph in platinum crucibles. The original palladium content in all catalysts was found to vary as widely as from 0.05 wt.% to 5 wt.% and the depletion of palladium during synthesis was found to vary from 10 to 60% of the original content. Diffraction analysis revealed the presence of palladium oxide as well as of metallic palladium in all spent catalysts before roasting and even after roasting at 873 K. Only roasting at 1273 K had resulted in complete recovery of metallic palladium. Thermogravimetric analysis revealed that roasting of spent catalysts up to 1273 K had resulted in a negligible loss of mass by catalysts spent in inorganic synthesis and an up to 9% loss of mass by catalysts spent in organic synthesis (7% by burning of carbonaceous impurities, 2% by dehydration). The alumina substrate was also found to be different, depending on whether the catalyst had been spent in organic or inorganic synthesis,  $\gamma\text{-Al}_2\text{O}_3$  in the first case and  $\alpha\text{-Al}_2\text{O}_3$  in the second case. The  $\gamma \rightarrow \alpha$  phase transition, normally occurring at 1373 K, had occurred already at 1173-1223 K in the presence of Fe (or Ti) impurity. Accordingly, palladium catalysts spent in organic synthesis should



be roasted at a temperature not lower than 1173 K. This temperature is also sufficiently high for palladium catalysts spent in inorganic synthesis. Treatment at that temperature and subsequent dissolution of palladium without dissolution of the alumina substrate, in a mixture of HCl and H<sub>2</sub>O<sub>2</sub> for instance, would be the most expedient method of reconditioning both kinds of spent catalysts and their mixtures in a single process. References 8: 1 Russian, 1 Bulgarian, 6 Western (4 in Russian translation).

2415/9835

CSO: 1842/88

UDC 621.762.274:669.24

#### ELECTROLYTIC PRODUCTION OF NICKEL POWDERS AND ITS DEPENDENCE ON ELECTROLYTE COMPOSITION

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNAYA METALLURGIYA in Russian No 4, Jul-Aug 85 (manuscript received 5 Jul 84) pp 102-103

[Article by A. I. Semenova and Ye. A. Orlova, Department of Heavy Nonferrous and Noble Metals Metallurgy, Leningrad Mining Institute]

[Abstract] A study of nickel powder hydrometallurgy was made, specifically for determining the dependence of the process yield on the Cl<sup>-</sup> ion concentration in the electrolyte. Experiments were performed in a thermostatic cell of 1 dm<sup>3</sup> capacity at a temperature of 55-60°C with a partition between the cathodic region and anodic region. The cathode, with a surface area of 8 cm<sup>2</sup>, was made of titanium. The anodes were replaceable combinations of insoluble lead and soluble cathodic nickel which allowed the nickel concentration in the electrolyte to be maintained at controlled levels. Electrolysis was conducted at two levels of cathodic current density, first at 2500 A/m<sup>2</sup> and then at 5000 A/m<sup>2</sup>, with circulation for maintenance of the necessary nickel concentration and of the pH within the 7.0-7.5 range in the cell. The electrolyte contained 10 g SO<sub>4</sub><sup>2-</sup> + 0.7 g NH<sub>4</sub><sup>+</sup>, or 30 g SO<sub>4</sub><sup>2-</sup> + 8.1 g NH<sub>4</sub><sup>+</sup>, or 60 g SO<sub>4</sub><sup>2-</sup> + 19.42 g NH<sub>4</sub><sup>+</sup>, with the amount of the Cl<sup>-</sup> ion in each case varied over the wide range of 3-15-30 g. The process with each of these nine electrolytes was tested for 1 h. The amount of electric charge passing through the electrolyte was measured with a copper coulometer. The nickel powder was washed threefold (with 50% H<sub>2</sub>SO<sub>4</sub> solution, water distillate, ethyl alcohol), dried, weighed, and sieved for size analysis. The results reveal a strong dependence of the process indicators on the Cl<sup>-</sup> concentration, the yield decreasing as the Cl<sup>-</sup> concentration is increased at fixed SO<sub>4</sub><sup>2-</sup> and NH<sub>4</sub><sup>+</sup> concentrations. As the Cl<sup>-</sup> concentration increases, nickel deposits in more bulky form and in smaller amounts, more of the electric current being spent on neutralizing the H<sup>+</sup> ion. References 5: 3 Russian, 2 Western (1 in Russian translation).

2415/9835

CSO: 1842/88

## FORMATION OF SUPERSATURATED SOLID SOLUTIONS ON COPPER BASE IN Cu-Cd SYSTEM DURING FAST COOLING FROM MELT

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNAYA METALLURGIYA in Russian No 4, Jul-Aug 85 (manuscript received 12 Nov 84) pp 115-116

[Article by K. V. Varli, Yu. A. Skakov and Ye. N. Tukalo, Department of X-Radiography and Metal Physics, Moscow Steel and Alloys Institute]

[Abstract] A study of Cu-Cd solid solutions was made, for the purpose of determining the feasibility of increasing the Cd concentration in copper beyond its maximum equilibrium solubility (2.1 atom.% at the peritectic point, 2.56 atom.% at 923 K) by fast crystallization from the melt. Molten Cu+ 3.3 atom.% Cd alloy was quenched at rates of  $10^5$ - $10^6$  K/s. The cadmium content in 20-35  $\mu$ m thick solid-solution ribbons was determined on the basis of changes in the lattice period relative to the lattice period in a copper standard. Subsequent x-ray diffraction analysis, metallographic analysis, and examination under a transmission electron microscope revealed a granular structure and presence of a  $\text{Cd}_8\text{Cu}_5$   $\gamma$ -brass phase with a lattice period  $a = 0.9588$  nm in addition to the metastable solid solution. References 2: both Russian.

2415/9835  
CSO: 1842/88

## DEPENDENCE OF STRENGTH CHARACTERISTICS OF SOME METALS ON PHYSICAL PARAMETERS OF ULTRASONIC TREATMENT

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNAYA METALLURGIYA in Russian No 4, Jul-Aug 85 (manuscript received 16 May 83) pp 116-118

[Article by L. A. Azizbekyan, Department of Physics and Mathematics, Yerevan Zootechnical Veterinary Institute]

[Abstract] Hardening of metals by thermoultrasonic treatment is analyzed on the basis of experimental data indicating the behavior of metals in a field of randomly traveling ultrasonic waves at relatively high temperature. A study was made on technically pure iron, copper, and aluminum - all three metals having a fine ( $\beta, \delta$ ) crystalline structure. Cylindrical specimens 10 mm in diameter and 100-120 mm long were first vacuum annealed in a quartz tube at 850°C (Fe), 650°C (Cu), 450°C (Al) for 2.5 h, for complete stress relief and buildup of a 30-40  $\mu$ m grain-size structure. They were then

ultrasonically treated with acoustic waves randomly traveling through the volume of metal, at a temperature approximately 40% below the melting point of each metal and thus below the recrystallization temperature in the range of maximum effectiveness. The treatment, within the 20-24 kHz frequency range and with the amplitude varied over the 5-40  $\mu\text{m}$  range, lasted 15 min - the period necessary and sufficient for attainment of the hardening effect. The substructure of specimens after this treatment was examined in an x-ray diffractometer with a  $\text{CoK}\alpha$ -radiation source and with widening of interference lines 220 (Fe), 222 (Cu), 400 (Al). The results confirm that ultrasonic treatment within the 20-24 kHz frequency range produces the maximum ( $\beta, \delta$ )-substructure buildup at temperatures below recrystallization, with intense  $\beta$ -widening beginning at vibration amplitudes of 15-20  $\mu\text{m}$  (Cu, Al) or 20-25  $\mu\text{m}$  (Fe) and the maximum grain disorientation angle also increasing with increasing amplitude of ultrasonic vibrations. Maximum hardening with completely developed substructure occurs under vibrations of 20-40  $\mu\text{m}$  amplitude, as indicated by microhardness tests. References 6: all Russian.

2415/9835  
CSO: 1842/88

UDC: 536.421.4

#### SPECIFICS OF CRYSTALLIZATION OF MULTICOMPONENT ALLOYS UNDER WEIGHTLESS CONDITIONS

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 5, Sep-Oct 85  
(manuscript received 15 Nov 84) pp 44-49

[Article by V. S. Zemskov, M. R. Raukhan and Ye. A. Kozitsyna, Moscow]

[Abstract] The major results are presented from experiments involving melting and crystallization of alloys in the quasibinary cross-section InSb-InBi of the ternary system In-Sb-Bi on earth and in weightlessness. The influence of weightlessness of specifics of phase distribution in the volume of ingots was studied, particularly on the dimensions, number and shape of primary crystals of the solid solutions  $\text{InSb}_{1-x}\text{Bi}_x$ . The work indicated a significant reduction in liquation processes in weightlessness. This is primarily manifested in uniform distribution of primary second phase crystals--solid  $\alpha$ -InSb solutions in the InBi matrix--as well as gas inclusions in the volume of the ingots. There was asymmetry in the boundary of dissolution of an indium antimonide ingot by an InSb-InBi melt, indicating the presence of residual liquation due to microaccelerations in the orbital flight of the Salyut-6 space station. References 16: 13 Russian, 3 Western.

6508/9835  
CSO: 1842/65

UDC: 669.22:533.9

INFLUENCE OF ALLOYING ELEMENTS ON STRUCTURE AND PROPERTIES OF ALUMINUM AT HIGH CRYSTALLIZATION AND COOLING RATES

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 5, Sep-Oct 85  
(manuscript received 18 Jun 84) pp 57-64

[Article by V. V. Kudinov, V. I. Kalita and O. G. Kopteva, Moscow]

[Abstract] Binary alloys based on high purity aluminum alloyed with B, Si, Sc, Ti, V, Cr, Mn, Fe, Co, Ni, Y, Zr, Nb, Mo, Ce, Hf, Ta and W with purity at least 99.7% were studied. Two alloys were prepared with each alloying element, with a content of the alloying element of 0.003-0.06 at.%. Binary alloys with an iron content of 0.1, 0.3, 0.6, 1.2, 2.0 and 3.0 at.% were also used in the study. The alloys were prepared in induction furnaces in an atmosphere of argon using master alloys. Wires were prepared and atomized onto copper drums using high temperature streams of argon. Specimens were prepared from the coatings on the drums for measurement of microhardness after atomization and after deformation by rolling at 290 K, total compression 78%. Supplementary resistivity, microhardness and grain size measurements indicated that alloying elements with higher ionization potential than aluminum make little contribution to increasing microhardness. Solid solutions with cerium, yttrium, cobalt and nickel have higher microhardness 320-360 MPa. Greater grain size reduction in the plane parallel to the cooling surface was observed for alloying with iron, cobalt, nickel, yttrium, cerium and hafnium and less reduction for alloys with titanium, vanadium, niobium, molybdenum, tantalum and tungsten. References 37: 23 Russian, 14 Western.

6508/9835

CSO: 1842/65

UDC: 639.233:669.14+669.28

DIFFUSION SATURATION OF STEEL WITH MOLYBDENUM UPON HEATING IN ELECTROLYTIC PLASMA

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 5, Sep-Oct 85  
(manuscript received 23 May 84) pp 90-92

[Article by N. A. Polotebnova and V. N. Duradzhii, Kishinev]

[Abstract] A study is made of the possibility of diffusion of molybdenum into steel. 12-molybdophosphoric acid  $H_3[PMo_{12}O_{40}] \cdot nH_2O$ , where  $n =$  up to 32 molecules of water, was used in the study. This acid is a strong electrolyte. Diffusion of molybdenum was studied in rods 10-12 mm in diameter made of armco iron and type 45 steel immersed into the solution to a depth of 17-18 mm. It was established that diffusion of molybdenum is



observed to a greater extent when an aqueous solution containing 10% 12-Mo-P acid and 10% hydrochloric acid is used. Further increases in 12-Mo-P acid concentration are impossible due to saturation of the solution.  
References 10: all Russian.

6508/9835  
CSC: 1842/65

UDC: 669.14.018.44:539.4.019.3

#### INFLUENCE OF ION IMPLANTATION ON CYCLIC STRENGTH OF VANES FOR MOTORS

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 5, Sep-Oct 85  
(manuscript received 28 Dec 84) pp 138-140

[Article by V. Ye. Zabolotnyy, V. P. Kvyadaras, N. A. Makhlin,  
V. F. Terent'yev and A. V. Fedorov, Moscow]

[Abstract] A study is made of the influence of the implantation of nitrogen and carbon ions on the endurance of stage three motor vanes made of the titanium alloys VT-8 and VT-18. Ion implantation was performed on a Vesuvius-1 installation (nitrogen ions, dose  $10^{17}$  cm<sup>2</sup>,  $E = 150$  KeV,  $T = 230-250^{\circ}\text{C}$ ). The method has the following advantages: it is independent of diffusion processes and the composition of surface layers can be modified by any chemical element or combination; the method allows alloying of the surface layer and acting on the level of mechanical properties without the presence of deep intermediate phases; by using the method one can reduce the consumption of scarce alloying metals. With proper selection of conditions it can be an effective means of increasing the fatigue durability of metals. References 3: all Western.

6508/9835  
CSO: 1842/65

UDC: 621.315.592

#### GROWTH AND MORPHOLOGY OF SINGLE CRYSTALS OF $\text{CuAl}_x\text{Ga}_{1-x}\text{Se}_2$ SOLID SOLUTIONS

Moscow NEORGANICHESKIYE MATERIALY in Russian No 10, Oct 85  
(manuscript received 20 Feb 84) pp 1656-1658

[Article by I. V. Bondar', A. A. Vaypo'in and L. S. Unyarkha, Minsk Radio Engineering Institute]

[Abstract] A study is made of the conditions for growth of single crystals of  $\text{CuAl}_x\text{Ga}_{1-x}\text{Se}_2$  solid solutions by the method of chemical transport reactions;



the morphology of the crystals is also studied. The crystals were grown in quartz ampules with an inside diameter of 16-22 mm and a length of 170-180 mm. The ampules initially consisted of two sections. In one of these a charge was placed containing the elementary components in predetermined stoichiometric ratios, quantity 3.0-5.0 g, while the other end contained a capillary with iodine (preliminarily evacuated and sealed). After evacuation, the ampule was disconnected from the vacuum system, the capillary containing iodine was opened, and it was transferred into the section containing the initial materials, and the second section was disconnected. The ampule was placed in a two-zone horizontal furnace in which the temperature was increased so that it was 100-150 K higher in the crystallization zone than in the reaction zone. When the temperature in the crystallization zone reached 970-1000 K, the ampule was held under these conditions for 2-3 hours; then the temperature was equalized in the two zones and gradually raised in the reaction zone over 5-6 days to 1030-1070 K. Chemical and x-ray analyses are used to determine the composition and homogeneity of the crystals produced. References 5: all Russian.

6508/9835  
CSO: 1842/64

UDC: 621.315.592

# ELECTROPHYSICAL PROPERTIES OF IRRADIATED SINGLE CRYSTALS OF $n\text{-Cd}_x\text{Hg}_{1-x}\text{Te}$ IN STRONG ELECTRIC FIELDS

Moscow NEORGANICHESKIYE MATERIALY in Russian No 10, Oct 85  
(manuscript received 30 Jan 84) pp 1677-1679

[Article by A. Sh. Abdinov, F. I. Mamedov, El'. Yu. Salayev, G. S. Seidli and K. I. Efendiyev, Azerbaijan State University imeni S. M. Kirov]

[Abstract] Results are presented from studies of the electrophysical properties resulting from hot charge carriers in irradiated  $n\text{-Cd}_x\text{Hg}_{1-x}\text{Te}$  single crystals, where  $x = 0.30$  and  $0.40$ , grown by slow cooling at a constant temperature gradient. Specimens were irradiated with  $\gamma$ -quanta with a power and dose of  $0.516 \text{ A/kg}$  and  $1.03 \cdot 10^5 \text{ Cl/kg}$  respectively from a  $^{60}\text{Co}$  source at  $350 \text{ K}$ . Effects were observed in strong microwave field which resulted from heating of the charge carriers, such as variation of conductivity as a function of the field intensity and thermo-emf of hot electrons. Bombardment with  $\gamma$ -quanta significantly influenced the electrophysical properties of the material studied in strong electric fields, which is explained by the development in the single crystals of radiation defects of both donor and acceptor type and of large-scale clusters. References 7: all Russian.

6508/9835  
CSO: 1842/64

## GROWING SINGLE CRYSTALS OF VANADIUM OXIDE BRONZES

Moscow NEORGANICHESKIYE MATERIALY in Russian No 10, Oct 85  
(manuscript received 20 Feb 84) pp 1750-1753

[Article by V. L. Volkov, L. D. Miroshnikova and V. G. Zubkov, Chemistry Institute, Urals Scientific Center, USSR Academy of Sciences]

[Abstract] A study is presented of the conditions for the growing of single crystals of vanadium oxide bronzes  $M_xV_2O_5$  by the Bridgman method in quartz conical-bottom test tubes with an inside diameter of 6-8 mm in air. The monoclinic oxide vanadium bronzes  $M_xV_2O_5 \cdot 8$  ( $M=Li, Na, K, Cu, Ag$  and  $Ca$ ) and a new hexagonal bronze  $Rb_{0.36}V_3O_7$  were grown in air. Radiographic studies were performed and the parameters of the unit cells of the single crystals determined. References 8: 3 Russian, 5 Western.

6508/9835

CSO: 1842/64

PROPERTIES OF PIEZO-CERAMIC BASED ON SOLID SOLUTIONS  $BiTiMO_6$  ( $M = Nb, Sb$ ) IN RHOMBIC LEAD METANIOWATE

Moscow NEORGANICHESKIYE MATERIALY in Russian No 10, Oct 85  
(manuscript received 6 Feb 84) pp 1757-1760

[Article by S. S. Lopatin, B. S. Medvedev and D. E. Faynrider, Rostov State University imeni M. A. Suslov]

[Abstract] A study is presented of the influence of the additives " $BiTiNbO_6$ " and  $BiTiSbO_6$  on the dielectric and piezoelectric properties of a rhombic lead metaniowate ceramic. X-ray phase analysis was performed in  $Cu K_\alpha$  radiation. The dielectric properties of ceramic disks 10.0 mm in diameter and 0.65 mm thick with silver electrodes were measured using bridges. Thermal expansion of the ceramic was studied with a quartz dilatometer. When  $BiTiMO_6$  (where  $M = Nb, Sb$ ) is introduced to lead metaniowate, the piezomoduli  $d_{33}$  and  $d_{31}$  of the ceramic materials are not greatly increased. Addition of " $BiTiNbO_6$ " has practically no influence on the mechanical quality or electromechanical coupling factor of the materials obtained. References 5: 4 Russian, 1 Western.

6508/9835

CSO: 1842/64

ETCHING OF SILICON WITH  $\text{HF}+\text{CrO}_3+\text{H}_2\text{O}$  SOLUTIONS

Moscow NEORGANICHESKIYE MATERIALY in Russian No 10, Oct 85  
(manuscript received 1 Feb 84) pp 1790-1791

[Article by S. V. Artem'yeva, A. V. Yukhnovich, L. Ye. Shuvayev and  
S. L. Leynova, Belorussian State University imeni V. I. Lenin; Scientific  
Research Institute of Physical and Chemical Problems]

[Abstract] The purpose of this work was the experimental determination of the stoichiometric coefficients in the equation of the reaction describing the dissolution of silicon in a polytetrafluoroethylene reactor thermostated at 293 K with solution volume up to 2.5 ml and silicon specimen volume up to 10 mg, assuring consumption of not over 2% of the initial etchant for full dissolution of the crystals. The volume of gaseous products of the reaction was measured with a gas microburette connected to the reactor. The experiment clearly demonstrated variation in stoichiometric coefficients  $\nu_1$  and  $\nu_2$  as well as the  $\nu_2/\nu_1$  ratio as a function of etchant composition. An increase in  $\text{CrO}_3$  concentration leads to an increase in  $\nu_2$  and a decrease in  $\nu_1$ , whereas the  $\nu_2/\nu_1$  ratio depends linearly on the chromium concentration in the solution. No variation of  $\nu_2/\nu_1$  as a function of HF concentration was observed. References 4: 2 Russian, 2 Western.

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CSO: 11842/64

UDC: 541.147:546.815.681.221

PHOTOCONDUCTIVITY AND OPTICAL ABSORPTION OF  $\text{PbGa}_2\text{S}_4$  CRYSTALS

Moscow NEORGANICHESKIYE MATERIALY in Russian No 10, Oct 85  
(manuscript received 8 Feb 84) pp 1791-1793

[Article by M. I. Karaman, V. P. Mushinskiy and V. M. Golovey,  
Kishinev State University imeni V. I. Lenin]

[Abstract] Polycrystalline  $\text{PbGa}_2\text{S}_4$  was prepared by melting the elemental components. Single crystals were obtained by vertical directed crystallization with a temperature gradient of 20-30 K/cm and a rate of withdrawal of 0.2-0.3 mm/hr. The spectral variation of the absorption coefficient was studied by measuring transmission and reflection of specimens 20-2000  $\mu\text{m}$  thick. The absorption spectra at 80 and 300 K indicate that natural absorption occurs at  $\lambda < 450 \text{ nm}$ . Cooling of the crystals to 80 K causes a shift of the long-wave boundary toward the shorter wavelengths. High energy reflection peaks are interpreted as a result of optical transitions from deeper energy sub-zones of the valent zone or as transitions from the valent zone into the conductivity zone. References 6: 4 Russian, 2 Western.

6508/9835  
CSO: 1842/64

## MANUFACTURE AND REPAIR OF HARD-ALLOY AND DIAMOND DRAW DIES

Moscow TSVETNYYE METALLY in Russian No 11, Nov 85 pp 70-72

[Article by L. S. Vatrushin]

[Abstract] In the manufacture and repair of draw dies it is essential to maintain three dimensions: a) angle of working zone; b) diameter of sizing zone; c) length of sizing zone. The performance of draw dies is largely determined by the drilling operation and the surface finish, a luster without dull spots contributing to a much longer nib life. The die manufacturing technology is governed by specifications pertaining to dimensional allowances and to grain size of the abrasive powder, different for hard-alloy (VK6, VK8) dies and for diamond dies, for their surface treatment which involves planing, grinding, polishing, and smoothing of transitions between zones, after drilling. Ultrasonic treatment is effective for repair of dies, namely clearing of surface and subsurface defects. Several machine tools are available for this purpose, the German-made NPKE-20 or TNP-10 (Urbanek GmbH in West Germany) was well as the Soviet-made NIA-S34. References 4: 1 Russian, 3 Western.

2415/9835

CSO: 1842/83

PRODUCTION OF SMALL CRYSTAL AND AMORPHOUS STRUCTURES ON THE SURFACE OF MASSIVE SPECIMENS BY MEANS OF CONTINUOUS CO<sub>2</sub> LASER TREATMENT

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 11, Nov 85, pp 17-20

[Article by A. G. Grigoryants, A. N. Safonov, A. F. Baskov, Ye. V. Kauts and V. S. Kraposhin, Moscow Higher Technical School imeni N. E. Bauman; Scientific Research Center of Foundry Technology, USSR Academy of Sciences; Institute of Problems of Microelectronics and Ultrafine Materials Technology, USSR Academy of Sciences]

[Abstract] The purpose of this work was to produce small crystal or amorphous structures on the surface of specimens of the alloys  $\text{Fe}_{77}\text{B}_{13}\text{Si}_{10}$  and  $\text{Fe}_{67.5}\text{Si}_{4.35}\text{B}_{19.7}\text{Cr}_{4.6}\text{Mo}_{2.5}\text{W}_{1.35}$  by using the radiation of a continuous CO<sub>2</sub> laser. Flat specimens were treated on a rotating attachment, the linear speed of processing being regulated by changing the rotation rate of the attachment and the distance of the specimen from the center of rotation. The rotating attachment was moved laterally so that the melted bands overlapped as it was rotated. The results of studies of the structure of the alloys showed that before laser treatment the structure of both alloys was



2-phased consisting of an  $\alpha$ -solid solution based on iron and a stable boride  $\text{Fe}_2\text{B}$ . Laser treatment formed melted strips of varying width on the surfaces. Treatment at a speed of 1.2 m/s or greater with an up to 3.6 kW continuous  $\text{CO}_2$  laser was found to produce on the surface of the alloys a layer containing an amorphous phase. Double laser melting and application of an absorbing coating onto the surface of the alloy before each treatment were found to be useful. Chromium, molybdenum and tungsten increased the tendency of the alloys in the system to form an amorphous layer under the influence of laser radiation. References 9: 3 Russian, 6 Western.

6508/9835  
CSO: 1842/86

UDC 535.21

#### MECHANISM OF SEMICONDUCTOR ANNEALING BY LASER TREATMENT

Moscow POVERKHNOST' in Russian No 11, Nov 85  
(manuscript received 29 Nov 84) pp 132-133

[Article by I. G. Gverdtsiteli, A. B. Gerasimov, Z. V. Dzhibuti and  
M. G. Pkhakadze, Tbilisi State University]

[Abstract] The mechanism of semiconductor annealing by laser treatment is hypothetically interpreted in terms of the melting process with attendant redistribution of bonding electrons and antibonding electrons and with the semiconductor crystal lattice becoming mechanically unstable at a critical concentration of the latter near the melting point. This theory is applied to germanium and silicon, but particularly to GaAs. Formation of a "cold liquid" in an amorphous semiconductor layer with a supercritical concentration of antibonding electrons and fluidity of GaAs single crystals upon irradiation by laser pulses are explained by a nonthermal photon mechanism, the established additive annealing effect of laser pulses not being compatible with a thermal mechanism. At a photon intensity insufficient for producing the critical concentration of antibonding electrons throughout the volume of a crystal, according to this theory, potential wells drain the antibonding electrons that exist and this causes the regions with potential wells to become annealed. The number of such regions increases with the number of successive laser pulses, while the diffusion coefficient for impurities in the crystal remains lower than at high photon intensity. References 8: 5 Russian, 3 Western (1 in Russian translation).

2415/9835  
CSO: 1842/89



## TREATMENTS

### NEW METAL EXTRUSION METHOD LAUDED

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 22 Aug 85 p 4

[Article by V. Lagovskiy: "Through the Barrier of the Impossible: Tests Are Going On"]

[Text] In the Institute of the Physics of High Pressures imeni L. F. Vereshchagin of the USSR Academy of Sciences, for the first time in the world, metal has been successfully machined by the method of high temperature gaseous extrusion.

"To the majority of people the term seems tricky and obscure, but, actually, everyone is well acquainted with extrusion. Moreover, they use it daily, pushing toothpaste out of its tube." Thus, simply and unexpectedly, did the deputy director of the institute, Candidate of Technical Sciences Yu. Konyayev, begin the account of the unique technology. In truth, it was difficult to believe that metal could be squeezed out so easily.

"It can" smiled the scientist, "if it is pressed upon very powerfully. A most reliable way to do this is with a liquid. Imagine that water is pumped into a tube of steel, like a piston it will begin to push out the paste. This is hydraulic extrusion. With gas extrusion, not a liquid but a gas serves as the piston."

"But, if everything is so simple," said I, taking an interest, "why could the installation not have been made earlier?"

"They did not know how" admitted Yu. Konyayev.

For hydraulic extrusion, the technology caught on right away. And it is not surprising. This is a fast method of machining metal practically without scrap. At one stroke it can press out parts of the necessary shape - pipes, shafts with slots, and even pinion gears. Imagine a ribbed "sausage" such that it remained only to cut off pieces of the necessary thickness to obtain finished gears. What is more, they are stronger and more plastic than the usual ones and they last longer. A huge pressure of 8,000 to 10,000 atmospheres is necessary so that the metal literally flows out through the narrow opening of the die, improving its internal structure.

Nevertheless, hydraulic extrusion has deficiencies; namely, it is carried out on cold blanks. But they would not be harmed by heat. Then the forces could be successfully lowered and, principally, refractory and high-strength materials could be machined. But heating the metal did not work well because the liquid surrounding the blank quickly lost its properties.

"Gas extrusion had to solve this problem" explains Yu. Konyayev. "Heating the gas does not interfere and the gas, itself, does not go bad. But to the majority of specialists, such a process seemed impossible. A number of foreign firms rather convincingly 'demonstrated' that a heated blank, overcoming friction, will come out of the die in jumps. One does not receive parts but lumps. It is possible that the die could be lubricated, as in hydraulic extrusion, but then the blank would have to be cooled."

It is a closed circle. The installation, however, for high-temperature gaseous extrusion is before me.

An idea of institute associate, V. Berbentsev, who now is in charge of the laboratory of gaseous extrusion, helped to step over the barrier of inertia.

Of course, the scientists did not need a day nor a month to calculate all the parameters in the matter accurately to prove their correctness. But why did they so unremittingly struggle just for gaseous extrusion? Actually, there are many other not less effective methods of machining metals with pressure.

Instead of an answer, V. Berbentsev pours out on the table a handful of very fine drills, milling cutters, and screw taps.

"These tools" said he, "cannot be forged or stamped out, they can only be turned on a lathe. Hence, every time, several grams of expensive steel are converted into shavings. Multiply them by the program of production, add the wear of the cutting tool, and the time of machining. High-temperature gaseous extrusion recovers all these streams of losses - almost finished articles come out of the die."

But there are cases when, in general, parts can be manufactured only by this method. For instance, Ukrainian physicists developed an unique high-speed cutting alloy made from powder. And it turned out that to press it into a very fine drill or milling cutter it is impossible to contrive anything better than gaseous extrusion. The new method could thus prolong the chain of progressive, wasteless technology.

That still is not all. After gaseous extrusion, heat treatment is easily done. The parts come out of the installation already heated, and, say, for hardening it is only necessary to cool it quickly. There is no need of a special furnace and there are no unnecessary expenditures of energy.

Industry still remains to be won over to the new method, but already it is clear that multipurpose wasteless technologies can be developed on its basis.

## HYDRAULIC IMPULSE DIE-STAMPING PRESS DESCRIBED

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 31 Oct 85 p 4

[Article by V. Bibikov: "When Water is Harder than Steel"]

One cannot believe that water can punch a hole in a steel plate. For some reason, water calls to mind quiet rivers on reedy shores and springtime dripping. From the evidence, scientists of the Physical and Technical Institute of the BSSR Academy of Sciences have done the unbelievable. In one of the laboratories, I was shown nothing remarkable in the way of an installation. Senior engineer V. Frantskevich pushed a button on a control panel. Out of the unit came a container with a die. The engineer placed a steel blank on it, and returned the container to the working position. A muffled blow was heard, and here is V. Frantsevich taking from the die, not a smooth sheet of metal, but a part resembling a knight's face guard with accurate, burrless openings in the side.

The deputy manager of the laboratory, Candidate of Technical Sciences A Skripnichenko explains:

"In special accumulators of the installation, compressed air is stored. When they are discharged into the space above a piston, the latter powerfully strikes the water covering the blank on the die. In a fraction of a second, the pressure in the chamber reaches 3,500 atmospheres and instantaneously becomes harder than steel. It gives the part the necessary shape and punches the openings. By the way, the installation can use an ordinary plant pneumatic system having a pressure of six atmospheres. It can be operated at any enterprise.

When, in the laboratory which was led by V. Chachin (who is now the rector of the Belorussian Polytechnical Institute) they began the development of impulse methods of moulding, it was a blank spot on the chart of technology. Of course, it was known that a jet of water under huge pressure could cut or crush metal as if it were paper. But it was necessary to develop a technology permitting the maximum simplification of the stamping equipment and tools. The search was crowned with success - the hydraulic-impulse installation fully satisfies the demands of industry.

"As you see, we managed without the traditional punch" says Academician V. Chachin of the BSSR Academy of Sciences. "As a result, the time and the funds for manufacturing dies was curtailed by a factor of two or three. In some cases the die can be made from composite materials and not from expensive alloy steels. And the metal consumption of the equipment itself is several fold less than traditional presses of the same capacity. It occupies less area and saves energy."

In the institute they showed me pipes, and several couplings having large differences in diameters. On an ordinary press, it would be impossible to obtain such a part. Hydraulic impulse die-stamping substantially simplifies the manufacture of complicated, deeply drawn parts out of specially strong materials. And if the equipment is fitted with a robot manipulator, it can operate in an automatic fashion.

In one of the installations, the Belorussian scientists replaced the water with polyurethane. It turned out that under specific conditions, it also can be "stronger" than steel. Polyurethane even has some advantages over water which permit simplifying the equipment itself. By the way, the equipment is not duplicated in the world. The technological equipment developed in the institute of the academy has been patented in a number of foreign countries, and was awarded a gold medal in the international exhibition in Brno.

Several installations manufactured in the experimental production unit of the academy already are being used in industry. The economic gain from their introduction amounted to about three million rubles. In a word, hydraulic impulse die-stamping has demonstrated its advantages in business. And the advantages were quickly appreciated - hundreds of enterprises have made applications to acquire the equipment. Recently the new presses underwent interdepartmental testing and were recommended for serial production.

9136

CSO: 1842/71

## SPECIAL NEW COATINGS CONDENSED FROM VAPORIZED MATERIALS

Moscow SOTSIALISTICHESKAYA IND'USTRIYA in Russian 31 Oct 85 p 4

[Article by V. Khokhlachev: "An Electron Gun in the Shop: Attention, Production Engineers"]

[Text] Installations developed in the department of new materials of the Institute of Electric Welding imeni Ye. O. Paton of the UkSSR Academy of Sciences develop almost 15 kilograms of vapor within an hour.

That indicator would belong to a category of more than moderate when speaking, for instance, about the operation of a TETs [Heat and Electric Power Station]. But, if it is taken into account that the unit developed by the Patonites is evaporating, not water, but metal, the quantity is impressive. Actually, later on, these kilograms, condensing in a vacuum, are precipitated on to prepared surfaces and harden on them in a smooth layer.

The powerful electron guns can convert into mist a whole collection of several metals or refractory alloys. From the intermixing flows, the most unexpected "cloudy" composites are formed. Ceramics can be included in them and fantastic "sandwiches" can be obtained having alternating diversified layers. For what are these transformations needed?

"Modern technology," says the department head, Academician B. A. Movchan of the UkSSR Academy of Sciences, "most often operates under extreme conditions and at maximum loads. Many traditional materials simply do not sustain them. Classic examples are the vanes of gas turbines which quickly go out of service because of the gigantic speeds, high temperatures, aggressive media, and power forcing. It is best to protect such articles with coatings made of so-called composites which combine within themselves the virtues of metals and nonmetallic materials. Installations equipped with electron-beam guns permit synthesizing precisely such 'hybrids'. By combining diversified substances, by regulating the grain size in the process of condensation, by regulating the size, shape, and quantity of pores, and by regulating the thickness of the microlayers, compositions with specified physical and chemical properties can be obtained."



The installations developed in the Institute of Electric Welding imeni Ye. O. Paton are supplied with an automatic control system based on a minicomputer and fitted with six electron-beam guns capable of evaporating and synthesizing various materials and of smelting metals and alloys.

Today, at the institute they are able to create three types of materials from the vapor flows; namely, dispersion-strengthened, microlayered, and microporous materials. The first of them, in a surprising manner, combines strength with plasticity. Ceramics and brittle metals such as chromium, molybdenum and tungsten lack precisely that harmony. In microlayers, metals alternate with alloys, carbides and oxides. In comparison with the rather thick sandwiches obtained by combined rolling, they have increased high-temperature strength and increased heat and electrical conductivity. Finally, the third group, the microporous condensates, are favorably distinguished by their filtration, sorption, emissive and acoustic capabilities.

These do not exhaust the list of virtues born from the vapor of materials. Changing the configuration of the base, any shape can be imparted to articles made from them, and changing the adhesive force with the surface can not only guarantee the strength of connection, but also, on the other hand, can guarantee easily separating the condensate from the base. So, either thin protective films or thick coatings can be obtained which are capable of becoming supporting elements of a structure.

Pure metals and alloys, polymetallic and composite materials made by the method of electron-beam vaporization and condensation in a vacuum are rapidly winning recognition. As one of the first, the new method was put into use at the Kursk Akkumulyator Plant. Here there was assembled a production line for the continuous deposition of coatings on steel tape. The reliability and durability of gas turbine vanes protected by the Paton method were sharply increased. The working temperature of the gas and the ceiling of peak power was successfully increased at a number of thermal electric power stations by means of new, high-temperature resistant jackets. Fuel consumption was reduced, and at each power unit a half million rubles a year were saved. But the results of the method's introduction at compressor stations on main gas pipelines exceeded everyone's expectations. The service life of the turbine vanes of the gas pumping units grew by a factor of three to four.

The popularity of materials condensed from the vapor phase is growing and they are being used ever more widely in machine building, instrument making, electrical engineering, electronics, and chemical technology.

9136

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## DYNAMIC STABILITY DURING INTERMITTENT CUTTING OF NONFERROUS METALS

Yerevan IZVESTIYA AKADEMII NAUK ARMYANSKOY SSR: SERIYA TEKHNICHESKIKH NAUK  
in Russian Vol 38, No 4, Jul-Aug 85 (manuscript received 30 Jan 85) pp 3-6

[Article by M. V. Kasyan and A. M. Arzumanyan, Leninakan branch,  
Yerevan Polytechnic Institute imeni Karl Marx]

[Abstract] An experimental study of machining LS59-1 brass and D16 duralumin was made on a 1Ye62M threading lathe, with a platelet of synthetic corundum as tool bit held by the cutter head. With the cutter head mounted on the spindle and the work piece mounted in the carriage, a weak link was inserted into the power loop of the machine tool and the depth of cut was varied at any given constant spindle speed. Two modes of operation were considered, one with regenerative vibrations and one steady. Absolute stability could not be attained in the latter mode, contrary to theoretical prediction, and stability was lost in both modes at a critical depth of cut within the 0.28-0.3 mm range. A theoretical analysis of the process must include open-loop and closed-loop amplitude- and phase-frequency characteristics of transverse vibrations, presence and absence of an elastic member in the feed mechanism corresponding respectively to those two modes of operation. Accuracy of such an analysis requires the use of a model as intricate as a system with an infinite number of degrees of freedom. Calculations and measurements over wide ranges of cutting velocity, depth of cut, and feed per revolution with a "Roza" ruby tool bit have yielded  $29^{\circ}23'$  as critical rake angle and 800 m/min as critical velocity for LS59-1 brass. Vibrations are generally smaller when the feed per revolution is smaller than the depth of cut and the stability limit is generally lower for D16 duralumin than for LS59-1 brass. References 5: 4 Russian, 1 Western.

2415/9835

CSO: 1842/68

MECHANISM OF WEAR AT LEADING EDGE OF CUTTERS MADE OF HIGH-SPEED TOOL ALLOYS  
DURING MACHINING OF STEEL

Yerevan IZVESTIYA AKADEMII NAUK ARMYANSKOY SSR: SERIYA TEKHNIЧЕСКИХ НАУК  
in Russian Vol 38, No 4, Jul-Aug 85 (manuscript received 20 Jan 84) pp 13-17

[Article by A. I. Sagradyan, Yerevan Polytechnic Institute imeni Karl Marx]

[Abstract] An experimental study of two new tool alloys V14M7K25 and V11M7K23 was made for an evaluation of their performance in cutting 45 carbon steel and 2Kh13 and R18 alloy steels over the wide velocity range of 5-120 m/min. The contact surfaces were examined metallographically and with a UKhA-5 x-ray microspectrum analyzer. The tool wear characteristics are, on the basis of this study, interpreted in terms of the iron-matrix "white layer" and its kinetics, governed by adhesion and diffusion of alloying elements, as well as in terms of the formation of carbides and intermetallic compounds harder than the tool initially. The thickness profile of that "white layer" is correlated with the distribution of shearing stresses over the width of the contact zone. The wear of those two tool alloys is compared with the wear of R18 and R9K5 tool steels at corresponding velocities within the 35-80 m/min range with the same feed rate  $s = 0.30$  mm/rev and depth of cut  $t = 2$  mm. The results indicate that the "white layer" acts as thermal insulator and thus as a thermal shield for the leading edge of the cutter, while at the same time preventing a direct contact between tool and chip so that intense adhesion, abrasion, and diffusion are avoided. This lengthens the life of cutters made of V14M7K25 tool alloy, but not of cutters made of much less plastic R18 or R9K5 tool steel. References 7: 5 Russian, 2 Western.

2415/9835  
CSO 1842/68

UDC 621.923.001.1

DEEP DIAMOND GRINDING OF TiN-BASE HARD ALLOYS WITHOUT TUNGSTEN

Kiev SVERKHTVERDYIE MATERIALY in Russian No 5, Sep-Oct 85  
(manuscript received 18 Apr 84) pp 53-55

[Article by Yu. Ya. Savchenko, V. I. Lavrinenko, S. M. Degtyarenko and I. P. Zakharenko, Institute of Superhard Materials, UkSSR Academy of Sciences, Kiev]

[Abstract] Deep diamond grinding of the TN50 TiN-base alloy without tungsten was studied in an attempt to establish the optimum conditions for this process. Tests were performed on 3A64D and 3V642 universal sharpening machine tools with hydraulic forward and lateral feed. Bars of the TN50 alloy 100 mm long and  $7 \times 15$  mm<sup>2</sup> in cross-section were ground with 12A2 diamond wheels of the 2724-0040 (150x10x3x32) size having a 45° chamfer, using a

100% AS 4 abrasive in various organic binders (BP2, TO2, B156, B1, O1, B11, B11-1, experimental B11-2). A grinding wheel with metallized AS4 diamond grains of the 100/80 fraction as abrasive in the B11-2 compound as binder was used for a separate performance evaluation of 13 lubricant-coolant fluids (3% Ucrinol-1 and 3% Aquol-2 aqueous oil emulsions, 3% semi-synthetic Aquol-11, 3% calcined soda, 3% borax, 1%  $\text{Cr}(\text{NO}_3)_2$  + 1.5%  $\text{NaNO}_3$  + 0.5%  $\text{NaNO}_2$ , 5%  $\text{NaNO}_3$  + 0.5%  $\text{NaNO}_2$ , 2.5%  $\text{NaNO}_3$  + 0.5%  $\text{NaNO}_2$ , 2.5% sodium tripolyphosphate, 5%  $\text{NaNO}_3$  + 3%  $\text{Na}_2\text{HPO}_4$  + 0.5%  $\text{NaNO}_2$ , 3%  $\text{Na}_2\text{HPO}_4$  + 0.5%  $\text{NaNO}_2$ , 2%  $\text{Na}_2\text{HPO}_4$  + 0.5%  $\text{NaNO}_2$ , 3%  $\text{Na}_2\text{HPO}_4$  + 0.2%  $\text{NaNO}_2$ ). The emphasis was on cooling, considering the high sensitivity of TiN-base alloys without tungsten to cyclic thermal loads. The results of this study suggest that a wheel with metallized diamond grains in the B11-2 organic binder and 3%  $\text{Na}_2\text{HPO}_4$  + 0.2%  $\text{NaNO}_2$  as lubricant-coolant fluid are the best combination for grinding this alloy. References 5: all Russian.

2415/9835

CSO: 1842/69

UDC 621.965:669.14

#### CIRCULAR HARD-ALLOY KNIVES FOR CUTTING MAGNETIC TAPE

Kiev SVERKHTVERDYIE MATERIALY in Russian No 5, Sep-Oct 85  
(manuscript received 9 Aug 84) pp 56-58

[Article by V. P. Artvukhov, G. I. Kovyshenko and O. P. Pruss, Institute of Superhard Materials, UkSSR Academy of Sciences, Kiev; H. Z. Abdulin, Tasma Industrial Association, Kazan]

[Abstract] For cutting magnetic tape in accordance with GOST 20958-80 All-Union State Standard, one now mounts imported circular knives made of a tool steel in Soviet-built SCH-20 machine tools. Two sets of knives are used for this operation: a row of sizing knives with 12.65 mm thick edge on the lower spindle and a row of cutting knives with 0.7-1.0 mm thick edge on the upper spindle. In an experimental study aimed at eventual domestic manufacture of those knives, the VK15 vanadium alloy was selected as the most suitable one. While sizing knives were produced in a single piece each, cutting knives were produced in the form of hard-alloy blades bonded with an appropriate adhesive to the steel hub. A special machine tool with an electric gear-motor drive has been developed and built for surface treatment of the knives by grinding with a free abrasive suspension in glycerin, ASM 28/20 diamond micropowder being used for rough finish and ASM 10/7 diamond micropowder for fine finish. Aqueous solution of calcined soda was found to be the best lubricant-coolant fluid. Experimental knives produced by this technology at the Tasma Industrial Association imeni V. V. Kuybyshev were tested on 40  $\mu\text{m}$  thick magnetic tape, cutting it at a rate of 60.0 m/min at an ambient temperature of  $20 \pm 5^\circ\text{C}$  and relative air humidity of  $65 \pm 15\%$ . The difference between maximum and minimum tape widths after cutting with these

knives was found not to exceed 0.03 mm, while it reaches 0.06 mm after cutting with imported knives. Also the durability of these VK15 knives is 400% higher than that of imported steel knives. Replacement of the latter has, accordingly, yielded a cost saving of over 100,000 rubles in one enterprise alone. References 5: all Russian.

2415/9835

CSO: 1842/69



WELDING, BRAZING AND SOLDERING

UDC: 621.791.14

CALCULATION OF TEMPERATURE FIELD UPON INERTIAL WELDING BY FRICTION

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 5, Sep-Oct 85  
(manuscript received 24 Sep 84) pp 40-43

[Article by R. K. Akhmedzyanov, V. I. Yegorov, V. V. Ivanayskiy and  
S. Yu. Panov, Barnaul]

[Abstract] A mathematical method is developed for determination of the temperature field generated upon inertial welding of dissimilar steels. The model describes thermal processes occurring during welding and drives a correcting factor for torque. The results can be used to describe and investigate the process of inertial welding and allow prediction of thermo-metallurgical changes around the welded joint during the planning stage, permitting selection of the most effective welding parameters from the standpoint of welded joint quality. References 6: all Russian.

6508/9835  
CSO: 1842/65

UDC: 669.295:621.791.75

INFLUENCE OF HEAT TREATMENT ON CRYSTALLINE STRUCTURE OF VT14 TITANIUM ALLOY WELDED JOINT

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 5, Sep-Oct 85  
(manuscript received 12 Oct 84) pp 126-130

[Article by A. A. Babareko, I. V. Egiz and M. A. Khorev, Moscow]

[Abstract] A study is presented of the influence of the heat treatment mode on the phase composition of an alloy and its degree of approximation of the equilibrium state, as well as the texture of the alloy VT-14 in various zones of a welded joint. Sheets 2.5 mm thick were welded with an argon arc machine then heat treated according to one of the following modes: annealing at 600°C, 30 minutes, cooling in air (1); annealing at 850°C,

30 minutes, cooling in air (2); hardening in water from 900°C after holding 30 minutes (3); hardening from 900°C in water plus aging at 400°C, 8 hours (4); or hardening in water from 900°C plus aging at 500°C, 8 hours (5). Argon arc welding is found to cause heterogeneity of the phase composition. Hardening from 900°C in water with subsequent aging at 400°C for eight hours yields a dispersion hardened state by segregation of the  $\alpha'$ -phase and almost complete decomposition of the  $\alpha''$ -phase in all zones of the welded joint. The most homogeneous phase composition and equilibrium composition of alloy phases, as well as homogeneous texture among zones in the welded joint is achieved after hardening and subsequent aging at 500°C. References 6: 4 Russian, 2 Western.

6508/9835  
CSO: 1842/65

UDC 621.791.763.1.03

#### USE OF DIRECT CURRENT IN READJUSTABLE SPECIAL-PURPOSE EQUIPMENT FOR CONTACT WELDING

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 10, Oct 85 pp 1-5

[Article by V. V. Smirnov, candidate of technical sciences, and O. N. Bokshteyn, engineer, All-Union Scientific Research Institute of Electric Welding Equipment]

[Abstract] The problem of devising a system of readjustable special-purpose welding machines for flexible automatic production lines with robotization can be solved by reducing the number of welding heads but imparting more degrees of freedom to each. Use of a d.c. power supply facilitates the solution of this problem in a manner compatible with the capabilities of available industrial robots. The advantages of operating with direct current are that the magnitude of the current does not depend on the distance from its source to the welding gun and that thus a single source can energize several welding guns at various distances from it. Also the power drawn from such a source does not increase excessively with increasing dimensions of the welding circuit, one terminal (pole) of the power supply being connected to the welding rod and the other terminal (pole) being connected to the welding gun in the fixture of the welding head above the work piece. The magnetic field of a direct current does not interfere with operation of the mechanized transport system, inasmuch as it does not induce appreciable stray emfs in components of that system located nearby. Such a d.c. power supply has been conceived on the premise that a conductor with a 1000 mm<sup>2</sup> cross-section can carry a current of 5 kA continuously. Then, as the distance from that source to a welding gun increases by 1 m, the additional power drawn is only approximately 5 kVA or 2.5 kVA for a nominal welding current of 12 kA or 8 kA respectively. All welding heads with fixtures and guns are connected to this

power supply through flexible cables of equal length so that the total electrical resistance remains the same in any configuration. Adequate water cooling is provided. A single-phase transformer as power source with the same capacity would have to have a power rating twice as high, while operation with alternating current would entail all the disadvantages which operation with direct current eliminates. A simple 4-electrode d.c. power supply UMT-01 has been designed and built at the Institute of Electric Welding Equipment for spot welding the jackets around electric-arc welding transformers. It can produce in one hour 60 jackets requiring spot welds at 44 points, and it supplies a power of 70 kVA for simultaneous welding of two spots with a current of 9 kA each. It can also be adapted for welding similar items of different dimensions within the same portal frame. Several UMT-01 power supplies have already been installed and are operating in three enterprises of the Soyuzelektroterm.

2415/9835  
CSO: 1842/70

UDC 621.791.052.08:620.179

#### MODERN EQUIPMENT FOR WELD QUALITY INSPECTION BY RADIATION INTROSCOPY

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 10, Oct 85 pp 5-8

[Article by F. R. Sosnin, doctor of technical sciences, Scientific Research Institute of Introscopy]

[Abstract] The applicability of radiation introscopy is determined by three basic performance parameters (absolute or relative sensitivity, ultimate resolution, productivity), as well as by the information content about defects (dimensions, location, type, shape, orientation), which must be weighed against those performance characteristics of nondestructive inspection by ultrasonic, electromagnetic, magnetic, capillary or other methods. Considering that radiation introscopy is eminently suitable for inspection and quality control of welds, equipment for this purpose has been modernized by replacement of the basic but not so efficient fluoroscope with radiation television. Such a system is available with an external scintillator or with an electronic x-ray image converter, the former offering higher resolution as well as higher luminous yield and the latter offering higher sensitivity. X-ray vidicons offer the highest resolution, but cannot be used for recording high-energy radiation quanta. An important item of auxiliary equipment for radiation introscopy is a manipulator for moving the inspection pieces. One such manipulator operating with an x-ray image converter tube can translate an object in three principal orthogonal direction as well as rotate it through  $n \cdot 360^\circ$  about one axis. Some equipment is produced by Introskop in the USSR. A major foreign producer is Philips in Holland and in West Germany, others are Isotopen Technik and Seifert in West Germany and Varian in the USA. References 14: 3 Russian, 11 Western (1 in Russian translation).

2415/9835  
CSO: 1842/70

## MACHINE FOR ULTRASONIC SEAM WELDING OF THERMOPLASTIC FILM MATERIALS

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 10, Oct 85 p 11

[Article by L. A. Shestel', engineer, and V. A. Sokolov, engineer, Omsk Polytechnic Institute; R. F. Yermakova, engineer, and V. P. Krysko, candidate of technical sciences, Ukrainian Scientific Research Institute of the Sewing Industry]

[Abstract] An ultrasonic welding machine has been developed and built for splicing 0.02-0.2 mm thick single-layer or multilayer film strips or sheets made of thermoplastic materials (polyethylene, dacron, polyvinyl chloride) doubled with chemically stable but not mechanically strong elastomers. This CUZU machine resembles a sewing machine and is similarly mounted on a work table. It consists essentially of a lever mechanism under a set of weights and an ultrasonic head with the welding tool. Under the table are mounted a support roller and two rubber-covered frictional pull rollers driven by a d.c. electric gear motor. Above the table are symmetrically mounted two pressure rollers under spring loads ensuring uniform transport of the welded material. The latest version of a standard UZDN-1 ultrasonic-frequency voltage generator with a power rating of 0.2 kW energizes the welding tool at a nominal frequency of 40+5 kHz, through a magnetostrictive converter with a conical vibration transformer soldered on and placed inside a container for water cooling. Electric controls ensure steady manual or semiautomatic operation with stepwise and smooth regulation of the welding speed over the 0-8 m/min range. The tool, with interchangeable tips, vibrates with an amplitude of 25-27  $\mu\text{m}$ . The machine produces a strong hermetic seam in continuous operation, requires 2-3 l/min cooling water, and together with the generator weighs 80 kg.

2415/9835

CSO: 1842/70

UDC 621.791.16

## MACHINE FOR ULTRASONIC WELDING OF ELECTRIC HEATERS

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 10, Oct 85 p 12

[Article by A. S. Filipenko, engineer, V. I. Povstyan, candidate of technical sciences, and A. S. Smirnov, engineer, All-Union Scientific Research Institute of High-Frequency Currents imeni V. P. Vologdin; Yu. V. Kholopov, doctor of technical sciences, Northwestern Polytechnic Institute]

[Abstract] An ultrasonic welding machine has been designed and built for reliable spot welding of electric heaters to storage batteries, specifically 0.7 mm thick copper busbars to 0.1 mm thick nickel conductors, instead of the



much less efficient and economical cold soldering. This MTU-1.0-UKhL4 machine consists of a welder and a UZG5-1.6/22 ultrasonic-frequency voltage generator. The welder includes a pneumatic drive operating with compressed air, a 1+0.15 kW acoustic head with cooling system, a welding cycle regulator, and a cassette feeding the materials into the welding zone. All these components are mounted on a chassis resting on a support frame. The machine operates semiautomatically at a nominal frequency of 22+1.65 kHz, drawing 5 kVA from an a.c. power supply. The welder alone weighs 260 kg.

2415/9835

CSO: 1842/70

UDC 621.791.052:539.56:669.295

# EFFECT OF DEFECTS ON IMPACT STRENGTH OF WELDED JOINTS MADE OF VT6 TITANIUM ALLOY

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 10, Oct 85 pp 16-18

[Article by A. A. Gel'man, engineer, K. D. Anuryev, engineer, N. M. Semenova, engineer, and L. M. Zaytseva, engineer]

[Abstract] A study of welded joints was made for the purpose of determining the role of defects in the kinetics of the welding process as well as their effect on the impact strength and the mode of fracture. Plates of the VT6 titanium alloy were welded together into butt joints and T-joints, this material with a coarse fiber structure being of particular interest. Joints were produced by various combinations of welding pressure and welding time, but all at the same temperature. The interplay of porosity in the parent material appearing as point defects and underweld sites appearing as line defects over the contact surface was examined under an electron microscope, the only instrument adequate for the quantitative metallography and fractometry of titanium alloys - after deep etching of microsections. Impact tests were performed on Mesnager specimens cut so as to include segments of the base material and the weld. The mechanical test data and the microstructural measurement data were processed mathematically by the method of least squares, for establishment of a correlation. An analysis of the results has identified a relation between the relative impact strength of a joint, namely the ratio of the impact strength of the weld to that of the base material,  $\bar{\alpha} = \alpha_s / \alpha_b$ , and the two kinds of defects. This relation is describable by two equations:

$$\bar{\alpha} = 0.44 - 0.02 \frac{\sum l_d}{L_j} \quad (l_d - \text{length of line defect, } L_j - \text{length}$$

of joint segment) for  $\bar{\alpha} = 0.1-0.4$  representing a linear dependence on line defects only in a low-quality joint and  $\bar{\alpha} = 1.06 - 0.38 \log n$  ( $n$  - surface concentration of point defects) for  $\bar{\alpha} = 0.3 - 1.0$  representing a logarithmic dependence on point defects only in a high-quality joint. Both porosity and underwelding determine, to different and varying degrees, the impact strength of a joint within the overlap range ( $\pi = 0.3-0.4$ ) corresponding to



the intermediate stage of the welding process. References 5: 4 Russian, 1 Western.

2415/9835  
CSO: 1842/70

UDC 621.791.754<sup>1</sup>.293

#### WELDABILITY OF DISPERSION-HARDENED VZhL14 CAST ALLOY

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 10, Oct 85 pp 18-20

[Article by F. N. Ryzhkov, doctor of technical sciences, V. M. Pletenev, candidate of technical sciences, and A. V. Bashkatov, candidate of physico-mathematical sciences, Voronezh Polytechnic Institute]

[Abstract] A study of the VZhL14 (KhN62MTYuL) dispersion-hardened heat-resistant cast alloy was made for the purpose of evaluating and improving its weldability to itself as well as to other alloys such as VNL1M and EP666. Joints were made by argon-arc welding with EP367 wire, according to standard practice, after the VZL14 parts have been quenched from 1150°C or quenched and then aged at 675-750°C. The cast structure of this alloy contains not only a  $\gamma$ -phase of solid solution but also a  $\gamma'$ -phase of  $\text{Ni}_3(\text{Al}, \text{Ti})$  intermetallic compounds and TiC pure or alloyed with molybdenum. Annular V-seams joining 15-20 mm thick parts were produced by several passes and then 100% inspected by color defectoscopy. Cracks were detected, intergranular ones with oxidized surface in all cases, which evidently had developed during welding either from original defects in the casting or from defects in the weld. Metallographic examination has revealed a distinct difference between surface cracks and internal ones. Proneness to hot shortness was found to be boosted by preliminary quenching and then to be abated by subsequent aging. Also, an alloy with 0.06% C and Ti+Al content at the intermediate level (according to OST 92-1166-75 All-Union Standard) was found to be much less prone to hot shortness than an alloy with 0.02% C and Ti+Al content at the upper limit. On the basis of this study, considering the high sensitivity to variations in alloy composition and in heat treatment, a new welding process has been devised for this alloy with an electron beam instead of an argon arc. An experimental comparative evaluation of both welding methods, on the basis of mean crack length (mm) per unit weld length (cm) as criterion, indicates a tremendous reduction of cracking to an almost negligible level. Whether the surface edges have been flashed, beaded, hardened, or not treated at all. References 4: all Russian.

2415/9835  
CSO: 1842/70

## ADHESIVE-WELDED AND PLAIN ADHESIVE JOINTS IN VOLGA AUTOMOBILE BODY ASSEMBLY

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 10, Oct 85 p 27

[Article by M. N. Levin, engineer, and L. N. Denisyuk, engineer, Gorkiy Automobile Plant]

[Abstract] Joints between metal parts in the body assembly of GAZ-24 small Volga automobiles are now either plain adhesive ones or adhesive ones boosted by spot welding, an adhesive filler also acting as sealant and corrosion inhibitor as well as vibration and noise suppressor. Laboratory tests and evaluation of two adhesives, UP-5-207 and PF-1, for joining 1 mm thick 110x20 mm<sup>2</sup> large parts made of 08kp carbon steel have yielded positive results after curing at 160°C for 30 min. Since both kinds of joints are approximately equivalent with respect to bond strength, there is a trend to replace adhesive-welded joints with plain adhesive ones. The latter are already used in assembly of door panels and will be used on the trunk lid.

2415/9835

CSO: 1842/70

## COPPER-ALUMINUM INTERFACE IN JOINT PRODUCED BY MAGNETIC-PULSE WELDING OF COPPER TUBE TO ALUMINUM TUBE

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 10, Oct 85 p 33

[Article by A. A. Yefimenko, engineer, Ye. I. Belen'kiy, engineer, and A. V. Kalenichenko, candidate of physico-mathematical sciences, Cherkassy Planning and Design Technological Institute; Ya. D. Korol', engineer, Cherkassy Pedagogical Institute]

[Abstract] In an experimental study copper tubes were joined with aluminum tubes by magnetic-pulse welding and by electric-arc magnetic-pulse welding. The best joints were produced by electric-arc magnetic-pulse welding with 2.7-2.9 kJ discharge energy, these joints having a structure with the brittle "white" phase just beginning to appear in the form of scattered inclusions. Metallographic analysis of the copper-aluminum interface revealed a buildup of the  $\theta$ -phase, a solid solution containing the Cu<sub>2</sub>Al intermetallic compound, with formation of 10-20  $\mu$ m wide continuous streaks during annealing. X-ray diffraction in a DRON-2 diffractometer confirmed this quantitatively, revealing not only a 100-200% higher Cu<sub>2</sub>Al content but also formation of several other among the 12 known Cu-Al intermetallic compounds. No macrostresses were detected in the transition layer, but microstresses were detected in copper grains. Annealing was found to relieve

those microstresses but, by also building up the intermetallic compounds, tended to degrade the quality of joints. References 1: Russian.

2415/9835

CSO: 1842/70

UDC (621.791.052:669.14.018.44):669.017.3

DEPENDENCE OF STRUCTURAL TRANSFORMATIONS IN 12Kh1MF STEEL DURING WELDING ON THERMAL CYCLE

Kiev AVTOMATICHESKAYA SVARKA in Russian No 10, Oct 85

(manuscript received 10 Dec 84, in final version 15 Mar 85) pp 6-10

[Article by N. I. Kamenskaya, candidate of technical sciences, All-Union Institute for Planning and Organization of Power Equipment Construction; K. A. Lanskaya, doctor of technical sciences, and L. V. Kulikova, candidate of technical sciences, Central Scientific Research Institute of Ferrous Metallurgy imeni I. P. Bardin]

[Abstract] A study of 12Kh1MF chromium-molybdenum steel (0.10-0.15% C, 0.9-1.0% Cr, 0.25-0.35% Mo, 0.15-0.30% V) with microadditions of 0.05-0.17% Zr, 0.002-0.003% B and 0.002-0.06% rare-earth metals was made under conditions of continuous cooling, simulation of the thermal cycle during welding of such a steel, for the purpose of determining the attendant structural and phase transformations. Specimens were heated above the  $A_{c1}$  temperature, at a rate of approximately 270°C/s from room temperature to the  $A_{c1}$  point and at a rate of approximately 200°C/s from the  $A_{c1}$  point to a maximum point  $T_{max}$  as high as 1350°C, and then cooled at various rates. The cooling process was regulated through program control of the electric current. Three cooling rates were selected for the 500-600°C range (2, 10, 100 °C/s), simulating the thermal conditions during manual electric-arc or mechanized welding under flux after a preheating to 250°C. Bar specimens 100 mm long and 8x3 mm<sup>2</sup> in cross-section were tested for weldability according to the IMET-1 method and also for transient mechanical properties and hardness. Hollow cylindrical specimens 6 mm in diameter with 1 mm wall thickness were used for microstructural examination and dilatometric tests, their phase analysis and dilatometric cooling curves revealing the kinetics of processes in the austenite melt. A comparison with plain 12Kh1MF steel indicates that, while cooling it at rates of 0.85-75°C/s causes the austenite to transform into pearlite, ferrite, or martensite, microadditions of Zr, B and rare-earth metals inhibit transformation into pearlite or ferrite at any cooling rate within this range and, instead, cause transformation into intermediate martensite (bainite) or martensite. Microadditions of these special alloying elements therefore improve the quenchability of 12Kh1MF steel and thus also improve its weldability. References 3: all Russian.

2415/9835

CSO: 1842/85

## EFFECT OF OXYGEN ON STRUCTURE AND MECHANICAL CHARACTERISTICS OF WELDED JOINT BETWEEN PARTS OF LOW CHROMIUM ALLOY

Kiev AVTOMATICHESKAYA SVARKA in Russian No 10, Oct 85  
(manuscript received 27 Dec 84) pp 11-14

[Article by Ye. V. Turtsevich, candidate of physico-mathematical sciences, O. G. Gorbatova, engineer, A. N. Rakitskiy, candidate of technical sciences, and V. A. Pisarenko, candidate of technical sciences, Institute of Materials Science Problems UkSSR Academy of Sciences; M. M. Nerodenko, doctor of technical sciences, V. V. Kundik, engineer, and G. A. Shevchenko, engineer, Institute of Electric Welding imeni Ye. O. Paton, UkSSR Academy of Sciences]

[Abstract] Embrittlement of chromium by interstitial impurities, particularly oxygen, was studied in the Cr + 0.5% V + 0.5% La alloy, for the purpose of establishing the optimum composition of the gaseous shield for welding. Specimens of this alloy were welded at the optimum rate of 2.8 mm/s in a controllable atmosphere of high-purity helium containing  $1 \cdot 10^{-4}$  vol.% O<sub>2</sub>,  $1 \cdot 10^{-3}$  vol.% N<sub>2</sub>, and  $1 \cdot 10^{-3}$  vol.% H<sub>2</sub>O vapor. The oxygen concentration was then increased up to 10 vol.% O<sub>2</sub>. The maximum allowable oxygen content in the helium shield was determined on the basis of microstructural examination of specimens under an EVM-100 BR electron microscope with 100 kV accelerating voltage, also by electron diffraction analysis and with an electronic microprobe, as well as on the basis of mechanical tests in flexure by the 3-point method. The amount of oxygen penetrating the seam of a welded joint was measured according to a special procedure with a Leko RO-16 gas analyzer. The oxygen content in a seam was found to remain constant at 0.002 wt.% O<sub>2</sub> while its concentration in the helium shield was increased up to 0.1 vol.% O<sub>2</sub>. The structure of such a seam was characterized by a high density of dislocations and micropore vacancies. With more than 0.1 vol.% O<sub>2</sub> in the helium shield, there appeared a second phase in the seam with dislocations at grain boundaries. Volume oxidation in the thermal influence zone was found to occur only under a helium shield with 10 vol.% O<sub>2</sub>. Surface oxidation of base metal as well as within the thermal influence zone, with formation of a Cr<sub>2</sub>O<sub>3</sub> film, was found to occur already under a helium shield containing much less oxygen. This film became thicker and eventually peeled off, as the oxygen concentration in the helium shield exceeded 5 vol.% O<sub>2</sub>, indicating oxygen saturation of the thermal influence zone. A phase analysis of the welded joints, including seam and base metal, revealed not only plain chromium oxides but also vanadium oxides and complex chromium-lanthanum oxides. Mechanical tests revealed an increase of microhardness and yield strength with increasing oxygen concentration in the alloy during welding. Oxygen evidently raises the cold-shortness temperature, corresponding to transition of the recrystallized alloy from plastic to brittle state. In order to ensure a welded joint of this low chromium alloy with a satisfactory combination of strength and ductility, it is therefore necessary that the oxygen concentration in the helium shield do not exceed 0.1 vol.% O<sub>2</sub>.  
References 7: 6 Russian, 1 Western (in Russian translation).

2415/9835  
CSO: 1842/85



## WELDABILITY OF CAST HEAT-RESISTANT NICKEL ALLOYS WITH 6% ALUMINUM

Kiev AVTOMATICHESKAYA SVARKA in Russian No 10, Oct 85 pp 18-24

[Article by K. A. Yushchenko, doctor of technical sciences, N. I. Pinchuk, candidate of technical sciences, A. A. Nakonechnyy, engineer, and A. G. Danilyak, engineer, Kiev; I. L. Rovenskiy, candidate of technical sciences, and A. V. Chemeris, engineer, Kharkov; V. F. Kotov, candidate of technical sciences, V. I. Shvarts, candidate of technical sciences, and G. A. Makhneva, engineer, Moscow]

[Abstract] A weldability study of cast heat-resistant alloys, the commercial ZhS6-U (6% Al + Ti, Nb) and the experimental LZhl (6% Al + 5-7% Nb + Ti) as well as its modifications LZhl-M (+Hf) and LZhl-I (+Y) was made, these alloys being produced by conventional casting or by conventional casting with directional crystallization for gas-turbine vanes. Specimens of the conventionally cast alloys, some 18 mm thick and some 30 mm thick, were cut from ingots and welded. Used as specimens of the alloys conventionally cast with directional crystallization were ready made vanes welded to disks of dummy rotors with annular welds. Manual and mechanized argon-arc welding was done by means of a tungsten electrode without and with filler and also by means of a fusible electrode in an argon atmosphere under an argon-base gaseous shield. Welding of the conventionally cast ZhS6-U alloy was also done with a preheating to 300-500°C. The results indicate an overall improvement of weldability to the same alloy or the EI698 steel as a result of directional crystallization. Vanes made of the directionally crystallized cast ZhS6-U and LZhl-I alloys were tested on experimental turbine rotors with successful results. A rotor with vanes made of the directionally satisfactory results. References 8: 4 Russian, 4 Western (3 in Russian translation).

2415/9835

CSO: 1842/85

UDC (621.791.75.01:669.018.45):536.2

## CONTROL OF THERMAL PROCESSES DURING WELDING OF HEAT-RESISTANT ALLOYS WITH FORCED COOLING

Kiev AVTOMATICHESKAYA SVARKA in Russian No 10, Oct 85 pp 24-25

[Article by U. I. Birman, candidate of technical sciences, Omsk]

[Abstract] Three schemes for controlling the heat supply to and the heat removal from the weldpool during welding of dispersion-hardened heat-resistant alloys with a refractory electrode under a gaseous shield have been developed and tested. Their common feature is localized action of heat



sources and heat sinks. In the first scheme a single heat sink is located at the tail end of the pool. In the second scheme there are three heat sinks, one at the tail end one on each of the two sides. In the third scheme heat is supplied from two sources and removed by one sink at the tail end. Forced cooling facilitates control of the thermal cycle as well as of the pool dimensions during the welding process, through regulation of the temperature gradient and the crystallization front; however, for this the heat sinks must be located in the immediate vicinity of the weldpool. Forced cooling of the weld and of the thermal influence zone can be designed to inhibit precipitation of the hardening  $\gamma'$ -phase in nickel alloys or of the Lawes phase in iron alloys and to otherwise control the phase structure of a welded joint. The third scheme is most effective, inasmuch as it favors directional crystallization along the weld axis. The pool, of egg shape during conventional welding with a refractory electrode, becomes spherical with a flat tail end during welding with the third method of forced cooling.

2415/9835  
CSO: 1842/85

UDC (621.791+621.791.3):669.018.45:629.12

#### WELDING AND BRAZING OF HEAT-RESISTANT ALLOYS IN SHIPBUILDING

Kiev AVTOMATICHESKAYA SVARKA in Russian No 10, Oct 85 pp 26-30

[Article by V. F. Kvasnitskiy, candidate of technical sciences, Nikolayev Shipbuilding Institute]

[Abstract] The problem with welding of dispersion-hardened heat-resistant molybdenum steels such as EP99 (KhN50MVKTYuR), EP202 (KhN67MVTYu) and EP539 (KhN60MVTYu) for power equipment on ships is hot cracking in the weld and in the thermal influence zone during crystallization, the extent of it and the resistance to it depending primarily on the chemical composition. An argon-arc welding technology and a laser-beam welding technology, also a brazing technology, have been developed for these steels which minimize this effect by application of special measures. Argon-arc welding is done preferably with a filler wire of EI683 steel (18.0-21.0% Mo + 14.0 - 16.0% Cr) and with molybdenum + boron added to the weld material. Welding with filler wire of other nickel steel such as EP367 (14.0 - 16.0% Mo + 14.0 - 16.0% Cr), EP533 (7.0 - 9.0% Mo + 19.0 - 22.0% Cr + 7.0 - 9.0% W + 2.3 - 2.9% Ti), EP648 (2.3 - 3.3% Mo + 32.0 - 35.0% Cr, 4.3 - 5.3% W + 0.5 - 1.1% Ti + 0.5 - 1.1% Al + 0.5 - 1.1% Nb) requires adding to the weld material molybdenum, molybdenum + tungsten, molybdenum + tungsten + chromium respectively. Least favorable to hot cracking is welding these steels in the austenitic state, austenitization at 1100°C rather than at 1200°C also ensuring adequate stress relief. Laser-beam welding produces joints of these steels with the same momentary and ultimate strength at 900°C as that of the base metal. Both welding methods require addition of deoxidizers such as aluminum and titanium to the weld material. The main problem with brazing these steels is ensuring adequate heat resistance of the joint, which can be

achieved by adequate wetting and spreading of the highly corrosion-resistant Ni-Si filler for smoothing the microroughness and dispersing the oxide film. Compression should continue till the base metal begins to dissolve and the residual pressure during diffusion brazing afterward should be sufficiently low,  $1 \cdot 10^{-3}$  Pa for the EP539 steel, to stabilize the critical wetting angle. With a plasmotron available, any filler wire can be used for brazing these steels. A multipurpose high-vacuum machine VVU-1D has already been developed and built for diffusion welding or brazing of large parts with intricate shapes. References 9: all Russian.

2415/9835  
CSO: 1842/85

UDC 621.791.75.042:669.14.018.44

#### DEVELOPMENT OF Sv-08Kh14N7KVM-VI WIRE FOR WELDING OF HEAT-RESISTANT STAINLESS STEELS

Kiev AVTOMATICHESKAYA SVARKA in Russian No 10, Oct 85 pp 30-35

[Article by V. Ye. Lazko, candidate of technical sciences, L. L. Starova, candidate of technical sciences, L. V. Tarasenko, candidate of technical sciences, M. T. Borisov, engineer, and I. Ye. Labzina, engineer, Moscow]

[Abstract] A filler wire for welding of heat-resistant stainless steels has been developed, the currently used Sv-03Kh12N9M2S-VI high-strength filler wire not being adequate for welded joints which are to withstand temperatures above 300°C. The research leading to this new filler wire proceeded in two stages: 1) preliminary selection of the wire material on the basis of direct determination of its properties on forged rods heat treated in the same manner as the base metal (quenching from 1000°C and subsequent aging at 520°C for 2 h); 2) refinement of its chemical and phase compositions on the basis of data on manual argon-arc welding of Kh15N5VM<sup>2</sup> steel, namely of 15 mm thick specimens heat treated to an ultimate strength of at least 1200 MPa. From the rough first selection of 08Kh15N5M2 filler alloy there evolved the final selection of 08Kh14N7KVM-VI (0.06-0.10% C, 13.5-14.5% Cr, 6.0-7.0% Ni, 0.5-1.0% Co, 0.3-0.5% Mo, 0.4-0.6% W, 0.1-0.5% Mn, 0.1-0.5% Si,  $\leq 0.015\%$  S,  $\leq 0.015\%$  P), on the basis of maximum resistance to embrittlement at temperatures up to 500°C as established by measurements of momentary strength at 20°C and 450°C as well as by impact tests with a regular notch 1 mm in diameter and an extra-fine notch simulating a fatigue crack after heating for up to 500 h. References 16: 13 Russian, 3 Western.

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## WELDABILITY OF AND ARC-WELDING TECHNOLOGY FOR HIGH-STRENGTH Al-Mg-Li ALLOY

Kiev AVTOMATICHESKAYA SVARKA in Russian No 10, Oct 85  
(manuscript received 19 Nov 84) pp 47-49

[Article by A. Ya. Ishchenko, doctor of technical sciences, A. G. Chayun, engineer, and R. V. Ilyushenko, engineer, Institute of Electric Welding imeni Ye. O. Paton, UkSSR Academy of Sciences]

[Abstract] A structural Al-Mg-Li alloy has been developed, with a corrosion resistance almost as high as that of the existing Alig6 alloy and with a 20-30% higher strength at room temperature after artificial aging than other well-known high-strength Al-based alloys. Its weldability is limited, however, by formation of bubbles which produce large pores in the surface layer during fusion welding, these bubbles forming as a result of decomposition of LiH and other complex unstable compounds formed in the surface layer by moisture entering the molten-metal pool and adsorbed by the friable thick oxide film. A technology has therefore been developed for welding this alloy with almost complete elimination of the problem. Conventional vacuum-heat treatment for removal of volatile decomposition products from the surface layer and its depletion of lithium is replaced by electromagnetic action of a pulsating argon arc, an arc produced by an asymmetrically alternating current and capable of stirring the lower layers of molten metal in the pool so as to facilitate the breakaway of bubbles and their surfacing prior to solidification of the metal. A low-frequency asymmetric square-wave current has been found to be more effective than a 50 Hz asymmetric sine-wave current or a 50 Hz symmetric sine-wave current with an electromagnetic stirrer. A special power supply I-126 for this welding process includes means of regulating current pulse of either polarity at 30-125 Hz repetition rates over the 50-300 A range of amplitude and a wide range of duration as well as means of forming pulse packets for amplitude modulation at frequencies of 1-10 Hz. Welding is done with a refractory electrode and a Sv-AMg63 filler wire.

References 8: all Russian.

2415/9835

CSO: 1842/85

## ELECTRON-BEAM WELDING OF ROTOR MADE OF VZhL-14N HEAT-RESISTANT NICKEL ALLOY FOR CENTRIFUGAL COMPRESSOR

Kiev AVTOMATICHESKAYA SVARKA in Russian No 10, Oct 85

(manuscript received 1 Nov 84, in final version 24 Dec 84) pp 50-52

[Article by G. F. Myal'nitsa, candidate of technical sciences, B. N. Shipitsyn, candidate of technical sciences, and R. V. Savichev, engineer, Nikolayev]

[Abstract] Electron-beam welding of the VZhL-14N heat-resistant nickel alloy, with high Al and Ti content, was studied and evaluated on specimens 15-20 mm thick and 80 mm in diameter. The quality criteria for optimizing the process parameters were considered to be complete fusion across the face and absence of defects in the casting as well as in the weld. These criteria were satisfied by an accelerating voltage of 28 kV, a welding current of 150 mA, a welding speed of 10 m/h, a residual pressure of  $1.33 \cdot 10^{-2}$  Pa, and  $H = 100$  mm. The optimum heat treatment of this alloy was also established, namely: austenitization at 1120°C for 3 h + air cooling before welding and austenitization at 1120°C for 3 h + aging at 700°C for 16 h + air cooling after welding. Following a satisfactory welding and heat treatment of cylindrical specimens by this process, as verified by x-ray analysis and fluorescent penetrant inspection, two collars made of this alloy were welded to an impeller wheel of a vertical centrifugal compressor wedged between them. References 3: 2 Russian, 1 Western (in Russian translation).

2415/9835

CSO: 1842/ 5

## WELDING OF VERTICAL WELDS WITH FORCED FORMING ON 10KhSND STEEL UNDER ARGON-BASE GASEOUS SHIELDS

Kiev AVTOMATICHESKAYA SVARKA in Russian No 10, Oct 85

(manuscript received 29 Oct 84, in final version 4 Apr 85) pp 58-61

[Article by B. F. Lebedev, doctor of technical sciences, S. D. Zagrebenyuk, engineer, V. G. Svetsinskiy, candidate of technical sciences, and S. T. Rimskiy, candidate of technical sciences, Institute of Electric Welding imeni Ye. O. Paton, UkSSR Academy of Sciences; G. M. Ginzburg, engineer, Trust for Power Equipment Installation in the Central Regions]

[Abstract] Mechanized welding of vertical seams during installation of water-graphite channel reactors in atomic electric power plants, such welding being done inside heated temporary sheds, is evaluated on the basis of an experimental study supported by experience in the USSR and abroad. The



expediency of welding by forced forming with solid filler wire under a gaseous shield has already been established,  $\text{CO}_2$  alone being unsatisfactory but in a mixture with argon being quite acceptable. In the experiment force forming of welds on 10KhSND steel was done in two passes on each side with solid Sv-08G2S filler wire under a shield of 70% Ar + 30%  $\text{CO}_2$  or 70% Ar + 25%  $\text{CO}_2$  + 5%  $\text{O}_2$ , in an A-1381 d.c. welding machine operating at a speed of 6.5 m/h with an arc voltage of 30-31 V and an arc current of 390-400 A from a VDU-504 rectified power supply. Both mixtures were found to yield welds with excellent mechanical characteristics as required, with a high concentration of acicular ferrite and with fewer uniformly distributed nonmetallic inclusions owing to a lower oxygen content, but the 70% Ar + 25%  $\text{CO}_2$  + 5%  $\text{O}_2$  mixture was found to ensure minimum wasteful splashing of the electrode material and thus facilitate formation of long welds. This process has therefore been approved for welding operations inside a special closed workshop for assembly of an RBMK-1000 MW water-graphite reactor. References 11: 9 Russian, 2 Western (1 in Russian translation).

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UDC (621.791.4:539.378.3):621.373.826:535.87

#### DIFFUSION WELDING OF MIRROR FRAMES FOR LASER-TECHNOLOGY EQUIPMENT

Kiev AVTOMATICHESKAYA SVARKA in Russian No 10, Oct 85

(manuscript received 20 Aug 84) p 72

[Article by V. V. Gromov, candidate of technical sciences, S. P. Yeftifeyev, engineer, G. M. Izakson, engineer, I. I. Minina, engineer, and L. A. Shternin, candidate of technical sciences, All-Union Scientific Research Institute of Electric Welding Equipment]

[Abstract] The resonator mirrors in ULGN-5.02 continuous-wave  $\text{CO}_2$ -laser equipment operate under heavy radiation loads and high coolant pressures, which requires a reliable bond between the substrate made of MOB copper and the frame made of M3 copper. The deformation of a mirror 100 mm in diameter must not exceed 1  $\mu\text{m}$  under a load of 500 W/cm<sup>2</sup>. The existing technology of producing such laser mirrors includes the use of POS-61 solder for joining together the two copper parts, but lumps of solder inevitably falling into the grooves distort the uniform coolant flow and produce hot spots. A feasibility study of diffusion welding as an alternative was made in an MVT-1601 machine with special fixtures ensuring uniform heat transfer to a mirror and residual strain levels not higher than 3%. The optimum welding process parameters established in this study are 10 MPa compression, 850°C welding temperature and 3 min holding time at that temperature. A lot of 30 mirrors was produced according to this procedure and then tested for



hermeticity, all having been found to remain leakproof under a gage pressure of 6 atm. Their optical distortion, according to interference measurements, did not exceed 0.25  $\mu$ m, which was 25% of the maximum permissible during cooling with water at a rate of 4 g/s. References 2: both Russian.

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UDC (621.791.14.052:669.245'293.018.45):(620.17+620.18)

STRUCTURE AND PROPERTIES OF HEAT-RESISTANT NICKEL ALLOYS FOR WELDED PARTS OF GAS TURBINE

Kiev AVTOMATICHESKAYA SVARKA in Russian No 10, Oct 85 pp 42-46

[Article by V. I. Shvarts, candidate of technical sciences, V. F. Kotov, candidate of technical sciences, M. I. Maresev, candidate of technical sciences, and G. A. Makhneva, engineer, Moscow; K. A. Yushchenko, doctor of technical sciences, and N. I. Pinchuk, candidate of technical sciences, Kiev]

[Abstract] A special group of three cast heat-resistant nickel alloys has been developed for the rotor vanes of gas turbines and compressors. They contain up to 6% Nb, niobium being a more effective  $\gamma'$ -phase forming element than aluminum and, with or without titanium, preventing loss of plasticity while boosting tensile strength and fatigue resistance. Another feature of these LZhl, LZh2, LZh3 alloys is an economy of scarce metals, inasmuch as they contain no tungsten (LZh2, LZh3) or no titanium (LZhl) and less molybdenum than do existing cast heat-resistant nickel alloys. The heat treatment they require is: 1) LZhL (65%  $\gamma'$ -phase) quenching from  $1200 \pm 10^\circ\text{C}$  in 4 h + air cooling; 2) LZh2 (25%  $\gamma'$ -phase) quenching from  $1165 \pm 10^\circ\text{C}$  in 3 h + air cooling followed by aging at  $785 \pm 15^\circ\text{C}$  for 16 h + air cooling; 3) LZh3 (50%  $\gamma'$ -phase) quenching from  $1180 \pm 10^\circ\text{C}$  in 4 h + air cooling followed by aging at  $800^\circ\text{C}$  for 10 h + air cooling. Their operating temperature are up to  $1050^\circ\text{C}$ ,  $750^\circ\text{C}$ ,  $900^\circ\text{C}$  respectively, the LZh3 alloy having a higher strength at  $900^\circ\text{C}$  and more plasticity than the existing ZhS6K alloy. They dispersion-harden at different rates, LZhl at the fastest and LZh2 at the slowest. One of these alloys, the LZhl, has been further modified for even higher heat resistance by addition of cobalt and graphite. Vanes made of these alloys can be fusion welded to rotor shafts made of 45 carbon steel, with weldable interlayer of EI893 or EI867 alloy, in the MST-51-5 welding machine under appropriate pressures during the heating-forging cycle. References 3: 1 Russian, 2 Western.

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## EXTRACTIVE METALLURGY AND MINING

### IRON ORE CONCENTRATION COMBINE IN KOSTOMUKSHA

Moscow OGONYOK in Russian No 47, Nov 85 pp 15-16

[Article by special correspondent Galina Kulikovskaya:  
"Kostromushka: Joys, Worries, Dreams...: A City in the Land of  
the Kalevala; When the Human Factor Does Not Work In Harmony; Not Only  
Pellets, But Porcelain."]

#### [Text] CITY

What are the charms of Kostomuksha? Great tranquillity, which is perceived in a modern city as something unreal; crystal pure air and an abundance of preserved nature as well as efficiency of planning, which despite being well thought out is not intrusive, but unaffected, natural, as are the pines and firs which are seen in the windows; a boulder, which looks like a sleeping bear, is left on a grassy plot for local color. Here, we see an avenue, here a smoothly curved parking lot for motor vehicles, motorcycles and mopeds, here a children's village...

The joint stock company Finnstroy, which participated in the construction of the combine and city, has issued a colorful booklet entitled "Kostomuksha, the 1st, 2nd and 3rd Sections". All the diagrams in the booklet are pictured against a rich green background. This background is like a green kingdom sprinkled with blue beads of large and small lakes, which are affectionately known here in Karelian as "lambushko or lambino".

Would you like some whortleberries or cranberries? Help yourself, they are only five minutes away from the apartment house entrance. And, we see the apartment house suddenly appearing from the pine forest, as if it were a sanatorium building, but it is not so small --five stories. Would you like to go fishing? Please, sit down and take the oars or raise a sail, and we wish you luck. But, make sure they are not motor boats or launches...They are absolutely forbidden in the waters of Lake Kontokki--the regulations for protection of the environment are very strict here. And, would you like to swim in the summer? Please be our guests: here is a sandy beach with all the amenities, just as good as in Yurmala. In short, it is a resort city and is maintained, as befits self-respecting resorts, in cleanliness, it should be said to the credit of the citizens, and very

great neatness. You will not see litter on its streets nor will you see their appearance spoiled by numerous structural repairs or alterations of sidewalks and streets.

In old cities, the residents turn their favorite streets, which retain the appearance of the ages imprinted in stone, into pedestrian streets. The citizens of Kostomuksha have not had to engage in such activity for the quite understandable reason of its young age--in May it was only two years old: the citizens had provided for such a street ahead of time. Maybe, it was planned as early as the drawing board stage of the development. And, it was named the Street of the First Discoverers [ulitsa Pervootkryvateley]. This street rises steeply alongside the lake in the very center of the city. At the top of the hill, the street is crowned with a monument of Soviet-Finnish friendship and the fruitful, good neighborly cooperation of the two countries. At the feet of the two monument figures, standing close to each other and not bending under the weight of a heavy slab on their shoulders, there are always fresh flowers. From this height, there is a wonderful view of the picturesque city that was built, as was the combine, by the efforts of thousands of Soviet and Finnish workers and engineers.

The pedestrian street, with full justification, could be named Childhood Street. On the side of the street opposite the apartment houses, there are kindergartens and behind them a school. And, there is an endless stream of all types of baby carriages going up and down the hill to the stores, polyclinic and post office. This is the only type of transportation permitted here and it is quite widespread in Kostomuksha. People laughingly say, "We have more baby carriages than pedestrians." This also gives rise to a problem: many mothers here stay at home. They have to stay at home. There are not enough kindergartens. The birth rate is growing rapidly. The local builders did not start building fast enough and now cannot keep up with the need for children's facilities nor for social and cultural buildings or housing--there are many waiting in line. There would have been sufficient housing for the combine miners and workers according to the original plans. But, they had to make room --apartments were needed for physicians, teachers, cooks, vendors. You cannot keep young specialists, coming from other combines in dormitories and "small family housing." So, here is the second problem that we learned of while talking to a friendly mother, coming down the hill with two small children.

#### HOW IRON WAS FOUND

We parted at the bottom of the hill, not far from the Palace of Culture, into which the pedestrian street runs. Our travelling companion went into a store and we stopped at an enormous block of ore, set up on a green carpet of lawn. This is what ferrous quartzite looks like that has brought to life in this northern land, if we may use the analogy of garden cities, this beautiful forest city. We recalled the musical lines from the immortal epic, lines from the

"Runes"; Vyaynyameynen tells of how iron was found in the land of the Kalevala. It hid "in the marshy swamps and bogs". Then, where should it be if not in Kostomuksha, whose name means a decaying bog?

We recalled the blacksmith Ilmarinen from "Kalevala". He placed his forge close to the bog and "he pulled the iron from the black earth and brought it right to the forge"...This could have happened in any other place and not in Kostomuksha...But that it was precisely in this village that the brilliant national poet, as M. Gor'kiy said about Elias Lennrot, wrote down the songs in 1837 is known for certain.

The tablet on the black boulder states that it is here in honor of the first discoverers, the modern Ilmarinens. Unfortunately, their names are not listed here. The documents in the museum tell about them.

Pilot A. Popov, navigator S. Vereshchagin and geophysicist Z. Makarova. It is they who first found here a powerful magnetic anomaly with the aid of the world's first aeromagnetometer, invented by the Leningrad professor A. Logachev; this took place in the summer of 1946 during the expedition's assignment of making a flight around the Kalevala region. Then, that winter the exploratory prospecting party of geologist P. Ivanov was already working here and confirmed the ore deposit nature of the anomaly. The outcroppings of the ferrous quartzites were found at a depth of one and a half meters. And, in the spring of 1947 Vasilii Ivanovich Makarin drilled the first hole. In the same year at the representation of the USSR Ministry of Geology and the Karelian government, Professor Logachev was awarded a State prize. Today we know that Z. A. Makarova, P. I. Ivanov and V. I. Makarin are among those who were honored with a 1985 State prize for discovering the Kostomuksha deposit. Incidentally, Petr Ivanovich Ivanov came specially for the unveiling of this memorial. And V. I. Makarin, a drilling operations expert, still lives here on International Street which is behind the Palace of Culture.

Makarin's apartment resembles a museum: there is an unusual vase in the foyer, a standing lamp made of a fallen alder tree is in the next room, an elegant bell tower is on the television set, and a devil guarding a birch box stands on the shelves...He has everything!

"When do you have time to make all these things?"

"We have a shift system. Four days drilling and three days off. So, I started making different things. I also enjoy reading."

Vasilii Ivanovich's voice is quiet, not shrill, like that of a man who has spent the greater part of his life in forests. He was born in a forest village, Velsk in Archangel Oblast, known for its timber base and logging booms.



"How did you get into drilling work?"

"In 1945 I was drafted, but not for the frontline, as the war was drawing to a close, but for the labor front. I worked for a short time in Petrozavodsk, then I was sent to a prospecting party. The party was looking for ore. Leningrad needed iron very urgently. And, in 1947 I came to the Kalevala region. We got to Kostomuksha on sleds drawn by horses. I remember it was March, but winter was still going strong. No roads, a god-forsaken place..."

"Where was your very first hole?"

"There where the open-pit mine is now. That first hole did not disclose any ore. We had two brigades. We drilled the odd numbered holes. The other brigade drilled the even numbered ones. They were more lucky, they hit iron. But, then our third hole turned out to be on the ore body. From that time on, I have worked in Kostomuksha and found a wife here. Mariya Ivanovna is a Karelian, Kivisalo is her family name. She was born right here in Kostomuksha. She has worked in the above-ground drilling operations, she learned how to lower candles. In 1954 the operation was closed. Mariya and I left. We returned as soon as we heard that another geological prospecting party, which established itself not far from Ledmoozero in the Zarechnyy settlement, had resumed operations here. It is in this party that I worked for the last fifteen years. So I consider myself an aborigine of this locale. I love our city. I have retired, but I continue to work with the geologists. Not at the drilling site...I do carpentry work now. And, my sons are here. Dmitriy is a crane operator, and Leonid is a chauffeur."

On this street, which is named International for good reason, lives the agglomeration specialist I. N. Salaychuk, born in the Ukraine; G. A. Gavrilov from Velikiye Luki is the driver of a 1000-ton BelAZ truck and a member of the Supreme Soviet Presidium of Karelia; V. E. Sychevskiy, a Belorussian, is the sintering machine brigadier and a deputy of the USSR Supreme Soviet...One can meet among the 30,000 residents of this town people representing fifty peoples and nationalities of our country. Specialists from all corners of our country from Rudnyy and Krivoy Rog, Staryy Oskol and the Urals rushed to Kostomuksha--they had to help the new combine stand on its feet more quickly.

#### GOK [Mining and Concentration Combine]

...And, a combine was developed to match the city. Dozens of buildings for primary and subsidiary industrial functions were built according to the strict rules of modern design: lower part of a building is light colored and the upper part is dark terra cotta, dark red or even dark brown, made of shaped metal. Even the overpasses and heat ducts are carried out in this color scheme: dark red grinders and silvery white chimneys. It is not difficult to imagine how grand



this looks against a green or white background on a dreary short day under a northern sky.

Inside, the industrial premises are also distinguished by good quality finishing and well thought out interiors. Here, light shades predominate, even white ones. But, if these colors are natural and are perceived to be there for good reason in the control, operational and dispatching rooms with displays and screens, then what can one say about a pellet production shop with white walls and white columns? Let us explain: the pellet sintering machine operates on mazut. Yes, on mazut. Everyone knows how much soot this black liquid, which remains after oil has been refined, emits while burning. The most surprising thing that we noticed was that the walls and columns of the building are still white. These are the "secrets" of shop chief V. I. Ivin, his assistants, workers and specialists.

This man who is rather short, gray-haired and wears glasses, was so engrossed in reading the papers he was holding that he could hardly be seen behind his large desk in his spacious office. There was not a trace of this deep concentration left as he, the host, led us the guests through the sections showing and explaining them.

"Only recently has this machine started to operate without soot; before, you had to get inside the sintering machine and see how everything was going...And you could never catch up on sleep. Mazut was not easy for us. Nowhere and no one operates with mazut, not at the Sokolovsko-Sarbaynsk GOK, not at the Ural GOK in Kachkanar, and I am not even mentioning the southern and central GOKs. All of them operate on natural gas. In Kustanay and Kachkanar they tried to operate with mazut, but were unsuccessful. A gas line was quickly connected to Sokolovka. The Kachkanars received gas from Nizhniy Tagil, which is right next to Kachkanar. However, in Karelia there is no gas and this problem will not be solved in the near future. Gas can come here only from Leningrad. A light blue flame is for us a light blue dream...At that time there was no way out, and the situation is still the same. We tried, we tried...It was just before the first sintering machine was put into operation that we succeeded in 'training' the Mazut."

Ivin finally stopped on an upper landing and we recovered our breath. He opened a small peephole in the sintering machine and we saw bright orange pellets, moving along the conveyor in a flame of the same bright orange color. Everything was red hot in this scorching heat, and it was difficult to believe that the source of this even pure fire was black mazut...

"Here you can see that the mazut does not give off smoke or odors. And, the sulfur cannot be detected." Now the shop chief was beaming. "Yes, it is somewhat warm here. But, the heat is pure, without the deadly odor."

## "I ASSUME THE RESPONSIBILITY"

When we returned to his office, we still had to ask him to tell us the story about how they 'trained' the mazut.

"There were two schemes for using mazut to sinter the pellets: the one worked out by the All-Union Scientific Research Institute of Metallurgical Heat Engineering in 1964, touched up and patched, but the same one that, to the shame of its developers, failed at the Sokolovsko-Sarbaynsk GOK. The other was a foreign scheme. The Ministry of Ferrous Metallurgy and the Ministry of Installation and Special Construction Work absolutely insisted on the domestic variant: there was little time left. We had to obey. But, when the mazut preparation and feed equipment was delivered and installed, the structure was so huge and clumsy that our local wits called it 'the cow in the bathhouse'--this raised some doubts about its work efficiency. But, the main trouble was that it proved to be unreliable. It forced out the mazut. The fuel supply, burner regulation and control of the entire operation of the system were not automated."

Ivin, supported by the GOK management, insisted on the need for a rush order abroad for burners with all systems automated and the fittings shop. There were many opponents to this plan. They doubted that the expensive foreign equipment could be successfully used together with the powerful Uralmash sintering machine. "And, if this does not succeed who will be responsible?" This is precisely the way the question was posed at one of the meetings. And then a rather short man, strong, and with a graying forelock stood up and said for all to hear: "I assume the responsibility."

Ivin would not have been Ivin if he had acted differently. He comes from the Magnetogorsk type people, people with strong characters. He is the son of a builder of the Magnitka mill and was born in the house that stood opposite that very same rolling mill, which his father built. Veniamin Ivanovich finished the tekhnikum in Magnitogorsk and worked for a while at the Magnitka mill. Then, after the institute, at which he was enrolled in evening courses, he found himself at the Sokolovsko-Sarbaynsk Combine; there he was a participant in that unsuccessful attempt to use mazut for sintering pellets according to the first scheme.

They [the GOK management] believed the shop chief of the Kostomuksha GOK. They believed him and trusted him!

The time for the first section to be put into operation was approaching, but the delivery of equipment was delayed. The equipment had to be coordinated and joined to the already installed machine assemblies. One can imagine how many sleepless nights Ivin and the shop workers had when the equipment arrived! Without stopping during the installation they replaced the elements that joined the burners to the prechambers of the sintering machine, and in their own way they arranged the units

and worked out a scheme for automatic control...Later, when representatives of the equipment company arrived, they shook their heads in surprise saying: "We could not have done this any better than you have..." Ivin saw that all was proceeding as it should, he encouraged everyone, and instilled confidence. Everything was checked many times, but deep inside every once in a while he was gripped by the chilling thought: "Suppose it does not work out, suppose something refuses to work, suppose it does not ignite?"

Finally, that long awaited day arrived, that hour, that moment when in the new large building an unusual quietness reigned. The lively voices of members of the commission for accepting the first GOK section, the representatives of the ministries, the guests from other combines, the builders and installers all became silent. The sinterer N. A. Tkachenko pressed the panel button, the automatic equipment was activated and the burner ignited. It burned with an even pure flame.

"You can't imagine what a joy it was! I recorded that moment." Veniamin Ivanovich, after searching his pockets, pulled out a little notebook. Here, he found: 15 June 1982 at 2250.

"Today is September 1985. Does this mean that all our difficulties are behind us?"

"Not at all!" All at once the shop chief looked troubled and returned to the state in which we found him. "The situation remains disturbing. Uralmash has produced some wonderful, powerful OK-520 sintering machines that one can be proud of. They are the best in the country. As far as automated systems, control systems and devices for mazut preparation and combustion are concerned, this still remains an open question. Imported equipment was installed immediately on the first two sintering machines. It was decided to manufacture domestic equipment for the third sintering machine. A plan of action was worked out. The deputy ministers of five ministries approved the special plan and schedule. Uralmash was designated as the main supplier plant. Here is the document."

Yes, here are the names of the responsible executives: V. Vinogradov, deputy minister of ferrous metallurgy; E. Zvizhilev, deputy minister of heavy and transport machine building; V. Karibskiy, deputy minister of instrument building; Z. Sadardinov, deputy minister of the Ministry of Installation and Special Construction Work; and, V. Reznichenko, deputy minister of the Ministry of Chemical and Petroleum Machine Building.

"How well was this authoritative schedule carried out?"

"The burners manufactured by Uralmash were installed on the third machine, and all the rest was imported. We were forced to go along with this or else the third section would not be operational."

"Didn't anyone assume the responsibility for this?"



"No one. Moreover, everything remains much the same now. We don't have any spare parts. All the contracts have expired. The equipment operates under difficult conditions--high temperatures and pressures. In a year or so, the equipment on the first machine will have to be replaced. Samples of the parts and assemblies have been sent out to all manufacturing plants. And, they are still there...Here is another relatively new document dated 14 January 1985."

Ivin took out from his portfolio two little green sheets. These are the minutes of the technical conference on mazut burners. All the parts and assemblies requiring additional work are listed and the agreed date: in the first quarter of this year the Uralmash Production Association, taking into consideration all the comments, will deliver a set of 30 jet burners.

"They were not delivered!" The shop chief is indignant. "We have only the jet burners; the component parts and the rest of the assemblies, which were to be delivered by the other plants, have not arrived and this is the end of the third quarter."

"And, what is the situation with the quality of the fluxed pellets?"

"This is the main concern of the entire combine. The success of this matter in the final stage depends on our shop. It is very important that the stability of the limestone and silica content in the pellets be ensured. If the proportions fluctuate, then it is difficult for the blast furnace operators to work, they have to make adjustments all the time, and change the conditions. Later, this affects the production of quality steel."

After a few moments of silence, he added:

"And the stability may be ensured by an automated system of technological process control."

Much to our amazement, it turned out that at such a brand new, modern combine as Kostomuksha is, there isn't any automated production control system and there still isn't a computer center...V. A. Enderov, chief of the automated control system department, spoke of this with bitterness. And, time passes on. The April (1985) Plenum of the CPSU Central Committee has raised new problems concerning scientific progress. The earlier allocated funds for their solution are already insufficient. The combine has the right to count on the assistance of the union organizations so that by 1990 it can complete the development of an automated control system.

#### LOOKING INTO THE FUTURE

Thus, as we became acquainted with the successes, worries and concerns of the city of Kostomuksha and the combine, we unintentionally touched upon their future. Indeed, what kind of future is it? What are the prospects for this city, one of the youngest cities of our

country? On this matter shouldn't we turn to those who are going forward, to the prospectors of tomorrow--the geologists? In the Zarechnyy settlement, Candidate of Technical Sciences V. Olennikov, who performs the duties of the head of the geological prospecting party, and N. N. Golubev, chief geologist and this year's State prize winner, were pleased that we came. They had subjects for conversation. They led us to a cupboard. We saw on the shelves a facing tile, a casting from a light blue stone, a white powder in a test tube, crushed rock, and a glass. Glaze. A faience pitcher. A cup made of thin porcelain that one wanted to hold.

"Do you like them? We do, too. All of this is made of accessory minerals found in the iron ore of the Kostomuksha deposit. These are fluorspars known as hilleflinta [Gelleflinty]. They are quite plentiful in the composition of overburden rocks; there are 650 million cubic meters of them within the contour of the projected open-cut mines. Following concentration, a fine transparent porcelain can be produced from them as the laboratory, technological and plant tests have shown; this type of porcelain is known as soft-paste low temperature porcelain which requires considerably less expenditure of energy and heat than conventional porcelain production."

"In Kostomuksha, can porcelain and glass factories be built and, thereby, the employment problem of the population be solved?"

"Not only these factories. First of all, a crushed rock plant, crushed rock is very much needed by Moscow and surrounding area and the Central Non-Chernozem Zone. Different departments plan to build their own mines at several sites in Karelia, and this will cost them much more than using Kostomuksha."

"Only one additional concentration factory is needed," said chief geologist Golubev as he continued Olennikov's story. "The economic estimates, made by the Kola branch of the USSR Academy of Sciences, showed that the porcelain, glass, and crushed rock enterprises alone can yield output worth 13-15 million rubles a year. The GOK will become essentially a mining industrial complex. Less waste materials will accumulate in the dumps, and this is a very favorable factor from the viewpoint of saving the environment. Meanwhile, a very valuable national economic raw material--hilleflinta -- together with other overburden rocks are being driven to the dump...Even now it can be stored separately. This is what worries us. We feel that the Ministry of Ferrous Metallurgy and the USSR Gosplan should utter a few impressive words."

"What is the situation with iron ore reserves?"

"The ore body here is extensive, there will be enough for the GOK for at least a half a century. We continue to study the region both in depth and width. There is ore. The only thing is that it is located under heavy bogs. On the whole, Kostomuksha will live and live."

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# CONSTRUCTION OF CEMA IRON ORE ENRICHMENT COMBINE STARTED

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 10 Nov 85 p 2

[Article by N. Cherkas under the rubric "Industrial News Item": "A Project of Friendship"]

[Text] Kirovograd oblast - - Construction of a large mining enrichment combine for the processing of low-grade iron ores for CEMA countries has begun near the rayon center, Dolinskaya, of the Kirovograd oblast. The first to arrive here were the construction detachments of the Soviet Union, Czechoslovakia and the German Democratic Republic. Soon they will be joined by constructors from Hungary and Rumania.

The first phase of the new GOK [Mining Enrichment Combine] will go into operation in 1990. Enriched ore will go from here to the blast furnaces of Krivoy Rog, Koshitse, Eyzenkhyuttenshtadt, Dunauyvarosh, and Galats.

According to the estimates of specialists, the raw material for the operation of the combine will last not less than 100 years.

9136

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SERIAL PRODUCTION OF NEW EXCAVATOR STARTED

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 10 Nov 85 p 2

[Article by A. Pavlov: "An Economical Excavator"]

[Text] Voronezh -- The Voronezh Production Association imeni Komintern has set to work on the serial production of excavators having an energy saving system. The machines underwent tests at construction sites in the Moscow oblast. It was established that the new excavators reduced fuel consumption by 17 percent, but productivity was increased by 12-15 percent.

Before the end of the year the association will turn out several machines with the energy saving system.

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## AUTOMATION OF PAVLODAR ALUMINUM PLANT DESCRIBED

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 24 Nov 85 p 1

[Article by G. Belotserkovskiy, staff correspondent, in Pavlodar: "Electronics Helps"]

[Text] More than 90 percent of the aluminum oxide produced by metallurgists at the Pavlodar Aluminum Plant earns the State Mark of Quality, and it has the lowest production cost in the industry.

The "secret" of success lies in the high standard of production and its very modern technical level. The unique electronic brain of the enterprise is the central automation and measuring equipment laboratory, which is equipped with electronic control systems.

"We don't shut off the systems, even for a second," says the laboratory's head, B. Mazur. "The process for obtaining aluminum oxide is so complex that the mathematical model for it would take up a small book of cumbersome formulas. And everything is intertwined: if the quality of the raw material changes, everything has to be recalculated. In the past, this now and then took weeks. Now the entire process is revised instantaneously, and it is even possible to play various production situations on the computer, to select solutions for future use."

It is no secret that automation wasn't trusted here until just recently: People relied more on intuition and years of experience. Some had gotten used to blaming their blunders on the equipment. In such cases, it was impossible to ascertain the truth without instruments. Electronic "inspection" became quite unpleasant for the careless. But even they, thanks to the engineers' persistence, soon understood how much easier it was to work the new way, without nervous strain. Material self-interest played a major role. If the automatic equipment functioned properly, everyone received a bonus; if not, reductions were made. In this way, they became accustomed to precise work.

Among those who initially did not accept the automatic equipment was sintering shop senior foreman S. Chervonnyy. But only initially. Then he became enthusiastic and brought the system to perfection. And...he became superfluous to his department--the computer assumed his functions. But they transferred

the foreman's accumulated experience to another section, where he also has been involved in automating production. After he has completed this work, Chervonnyy will manage two sections at once. Since they will be consolidated, management will be even easier. The foreman's field of activity will expand and his work will become more interesting. The problem of reducing the plant's management apparatus also will be solved. Chervonnyy's case is not the only one.

Tatyana Borisovna Potapova, Candidate of Technical Sciences, is head of the aluminum oxide production automation laboratory opened at the plant by the Leningrad All-Union Research and Planning Institute for the Aluminum, Magnesium, and Electrode Industry. She has worked in Pavlodar for 10 years already. The Leningrad people participated in designing the plant and are now actively involved in automating it.

"You won't solve anything by sudden visits and attacks," says T. Potapova. "You might say that you have to become a part of the system, to live and breathe with it. I say thanks to the workers at Pavlodar, who accepted our approach: once the process control system is switched on, even though it's incomplete, don't shut it down under any circumstances, but bring it up to standard. For this reason, the system has run error-free for several years and has made it possible to reduce annual expenditures for raw material and electric power by 3 million rubles.

Together with the Pavlodar workers, the Leningrad people have done tremendous work, having fundamentally rearranged the entire production facility and connected the equipment into continuous flow lines. All sections have been fitted with the system's "nerves"--reliable instruments. A unified data base is operating at the plant. Automatic samplers send charge samples to the laboratory by pneumatic tube conveyor. The results of analysis are entered into the computer's memory. It transmits data to jobsites. As a result, long telephone conversations became unnecessary. Remote unit control also has appeared in the shops. One only has to press a button on the control panel, and the pumps and shut-off valves are activated. In the blink of an eye, back-up units are brought on line. A year or two ago, shutdown for cleaning and start-up of the huge pools and evaporator plants was a job only for strong men.

Every year automation makes it possible to relieve dozens of men of hard physical labor. One-third of these, as is the custom here, go on to strengthen the electronic unit and augment the programmer staff. Technological changes have brought about social changes. Work has become more creative, interesting, and clean. People are more careful with equipment: Electronic equipment won't tolerate a rough, approximate process.

Various local automation systems monitor two-thirds of the production facilities at the aluminum plant. They are now being introduced in the chemical-metallurgy shop. In the next five-year plan, it has been decided that the entire plant will be subject to electronics and all local systems

will be united into one. Scientists and production specialists are working on this, creating a dynamic model of the entire aluminum oxide production facility. An "all-encompassing" automated process control system will start operating, first in an advisory capacity, in 1987.

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## ELECTROSLAG SMELTING OF COPPER ALLOYS FROM LOOSE BATCH

Moscow TSVETNYYE METALLY in Russian No 11, Nov 85 pp 61-63

[Article by B. Ye. Paton, Yu. V. Latash and I. V. Lyutyy]

[Abstract] A new electros slag smelting process has been developed at the Institute of Electric Welding (UkSSR Academy of Sciences) for production of copper alloys with maximum utilization of slag and metal tailings, a contribution to an overall economy of scarce nonferrous metals and especially of raw copper. The process involves melting a slag of specific composition in a lined furnace-crucible by an electric current fed through nonconsumable carbon electrodes, carbon being chemically resistant to most slags and passive in relation to most copper alloys. A clinker lining for the crucible or water-cooled metal electrodes are acceptable for the exceptional cases. The slag remains in the furnace, while the molten metal is poured into a ladle, a mixer, or a mold for further processing. The essential features distinguishing this process of conventional electros slag smelting processes are: 1) high slag content in the furnace-crucible; 2) use of low-viscosity halide and oxide slags melting below the metal pouring temperature and thus acting as coolant as well as decontaminator; 3) gradual feed of slag at a rate approximately equal to the rate of metal melting; 4) liquidation of oxide inclusions in the slag, oxides of copper and of alloying metals through reduction by the carbon electrodes and by specially implanted charcoal, oxides of silicon and aluminum through incorporation into the slag; 5) use of carbon lining impermeable to molten copper and other metals, and thus reusable for smelting of different alloys without wash and rinse. References 2: both Russian.

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CSO: 1842/83

## USE OF FROTH SEPARATION IN MOLYBDENUM REFINING CYCLE

Moscow TSVETNYYE METALLY in Russian No 11, Nov 85 pp 83-85

[Article by K. I. Lukina]

[Abstract] A feasibility study of molybdenum refining by froth separation has confirmed that this method facilitates extraction of freely floating mineral grains from crude molybdenum concentrate much more effectively than conventional froth flotation from pulp. The crude concentrate, after having been chemically processed and before being completely comminuted, is fed onto or into the froth layer so that hydrophobic particles will congregate on air bubbles to be easily removed as foam while hydrophilic particles will pass between air bubbles to be easily dumped into the flotation chamber. This method yields, after the second pass, a 10% molybdenum-rich concentrate. References 2: both Russian.

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## SEPARATION OF NONMAGNETIC NONFERROUS METALS IN TRAVELING MAGNETIC FIELD

Moscow TSVETNYYE METALLY in Russian No 11, Nov 85 pp 85-87

[Article by O. M. Cherepnin, A. I. Shevelev and I. G. Shaimova]

[Abstract] A feasibility study was made concerning the use of electrodynamic separators with traveling magnetic field for separation of comminuted mixed nonferrous metal scrap from the electrical equipment manufacturing industry. Scrap consisting of teleprinters, switchboards, control panels was crushed with hammers prior to magnetic separation for removal of ferromagnetic material and pneumatic separation for removal of dust and powder. An analysis of the scrap material afterwards revealed a mix of 53.13% aluminum alloys, 12.6% insulated copper, 8.1% copper alloys, 4.37% bare copper, 5.77% aggregations, and the rest including remnants of carbon steels and alloy steels, plastics, ceramics, wood, cardboard, paper, and rubber. An analysis of the size distribution and an analysis of the force field establish the necessary process parameters which make it feasible to salvage aluminum alloy from -100+40 mm size scrap at a rate of 3 t/h. References 3: 2 Russian, 1 Western.

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DISINFECTION OF BIOLOGICALLY PURIFIED WASTE WATER BY RADIATION TREATMENT

Moscow TSVETNYYE METALLY in Russian No 11, Nov 85 pp 87-90

[Article by Ye. P. Petryayev, V. I. Vlasova and N. N. Subbotina]

[Abstract] Disinfection of waste water by radiation treatment, particularly of cooling water in reversible closed water supply systems, is an important factor in the overall water conservation program. Disinfection by radiation treatment ensures a stable and reliable bactericidal effect. While ionizing radiation not only destroys bacteria but also causes oxidation of toxic and biologically nondecomposable substances as well as accelerated precipitation of colloidal substances, polymerization of monomers, and deodorization of water,  $\gamma$ -radiation causes changes in the DNA structure in bacterial cells. Radiation treatment is preferable to chemical treatment with chlorine, which only causes changes in the metabolism of bacterial organisms. In the USSR experimental radiation treatment of waste water and its sediments is being done in industrial and semiindustrial facilities for analysis and evaluation of its effects. In one such study samples of waste water from the Gay mining and ore dressing combine as well as samples of Gay city sewage have been treated with  $\gamma$ -radiation from a  $^{137}\text{Cs}$  source in an LMB- $\gamma$ -LM isotope unit. Results of chemical analysis, before and after repetitive fractional irradiation, reveal the mechanisms of the disinfection process and its beneficial effect on the quality of water. They also indicate the feasibility of reducing the necessary radiation dose by using activated carbon sponge as an auxiliary disinfectant, this material being continually renewable by also being irradiated. The mechanism of that recovery is not yet definitively known; it could be generation of new active centers or release of old active centers through annihilation and volatilization of the absorbed substances. Addition of irradiated water to nonirradiated reduces the bacterial content in the latter, not by dilution but by destruction. Experiments with such mixing, twice or several times in succession, indicate that the quality of stagnant waste water can be raised to the level of river water with a considerable economy of radiation resources, owing largely to a buildup of  $\text{H}_2\text{O}_2$  and other oxidizers in the irradiated sample. On the basis of preliminary data, the overall cost of radiation treatment is comparable to that of conventional treatment so that radiation treatment can be recommended for disinfection of biologically prepurified waste water. References 8: 7 Russian, 1 Western.

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